

International Encyclopedia of Systems and Cybernetics

International Encyclopedia of Systems and Cybernetics

2nd Edition

Charles FRANÇOIS
Editor

Part I
A – Metron

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Introduction to the Second Edition

The challenge to reason

The first edition of this Encyclopedia has been well received and, I dare hope, useful to those who took interest in it.

During the seven years after its appearance, so many events happened worldwide, that this kind of work can now be seen in a quite different light.

I never believed that it would concern only scholars and, among them only those not affected by specialized tunnel vision.

It has not of course reached Jane and John Citizen, at least not yet.

Their world, our own world, has been however violently shaken and deeply troubled by new challenges as well as by insidious but pervasive doubts about basic beliefs and even perhaps about the very survival of our species in the near future.

As stated by Bertrand RUSSELL (quoted by Søren BRIER): "The whole problem with the world is that fools and fanatics are always so certain of themselves, but wiser people so full of doubts". This is still truer today than it was when Russell was observing the confuse and confusing spectacle of mankind, i.e. until his disappearance in 1970.

Meanwhile the challenge to reason is worsening day by day. It is not merely its negation by the "fools and fanatics". As Stafford BEER pointed out, it has even more to see with the ill-informed, sloppy and/or devious use of reason itself. Moreover such a fake rationality is frequently put at the service of ill-conceived (and in cases, abusive) designs, proposals and decisions. Just to take an example, let us ponder the massive Aral Sea disaster. ("see site <http://www.dfd.dlr.de/app/land/aralsee/>)

We are evermore victims of what Jean FOURASTIE called "the ignorance of ignorance" (much worse than simple ignorance, as it leads to insolence and imprudence). In a similar way we sink into the swamps of "underconceptualization" (John WARFIELD)

Personal musings on the systemic path

Now, how could Systems and Cybernetics be of any use about all this?

Of course, it could help to ward off the territories of ignorance and deepen the understanding of what happens, and why we are generally so helpless about it.

At least my own inquiry has brought me food for thought about a number of brand-hot present issues.

Only one example will do. I became in the recent years more and more interested in the so-called neural networks, as models for multi-

ple interactions among a great number of elements within a specific area of activity and in accordance with some rules of communication and action.

I quickly discovered that neural networks could help to transform analogies into models for very different kinds of situations. They better the understanding of insects societies, but also the propagation of epidemics (AIDS for example) using the complementary model of "small world". They better explain the progress of forest fires, or stock market crashes, or the swift diffusion of ideologies or fads, with the help of "memes". It makes clearer the changing world economy, or the workings of the world-wide electronic web.

It also changed the understanding of this editor about communication means and codes, be them pheromones, pathogens, money, electronic pulses or human languages.

Many other examples of this kind could be offered.

The conceptual toolkit in perspective

In short, systems and cybernetic models, when organized into a coherent language, become an exceptionally valuable methodological toolkit for the study of any complex issue.

By the way, let us not anymore sink into the morass of controversy about so-called "theory of systems", what it is or not, what it should be or not. The topic is of course interesting, but it should not detract us from practical purposes, nor make us appear as abstruse and inconsequential.

As the spanish philosopher Ortega y Gasset once said, let us go to the "matters" ("a las cosas", i.e. to the issues at hand)

It is nevertheless also important to understand that systems thinking (and acting) introduces a new approach to the "matters" and is arguably the most significant conceptual mutation in Western thought, at least since Renaissance.

I tackled this subject in my 1997, 1998, 2002 and 2003 papers, in order to make clearer my own mind (and hopefully my readers minds) about the deeper meaning of this new way to manage our ideas and behavior.

In this sense, I am struck by some significant aspects:

- Systems thinking operates a general mental and psychological re-orientation (or "re-polarization") that implies a kind of impulsive self-reference about one's own way of thinking. This leads to the conscience of a conceptual implicate order (more or less in the sense of David BOHM's cosmic implicate order) in which the more specific "explicate" models create from specialized or discipli-

nary viewpoints, can be connected and put into a general perspective.

This is at least the feeling I acquired after more than 45 years of reflexion on the subject.

- In a parallel way, the "world out there" (of Heinz von FÖRSTER) has been massively transformed during the last 150 years through the impact of a more and more extended use of energy. Thousand of small, and more or less isolated communities and tens of supposedly "independent" nation-states are being forcefully connected within a "one world" in the making (as clearly seen already by Wendell WILLKIE, unsuccessful US presidential candidate in 1940.)

This is at the same time a "creative destruction" process (Joseph SCHUMPETER) and the emergence of a hyper-complex whole system through "dissipative structuration" (Ilya PRIGOGINE). Both aspects reflect a powerful new structural dynamics.

- Caught in the throes of such a dramatic transformation, human societies seem to suffer a kind of overpowering social pathology and are probably starting to undergo a groping immunological process somehow similar to the biological acquisition of antibodies.

- In my opinion the appearance of systems and cybernetics thinking during the 2nd half of the last century is an important- and possibly even one of the decisive events in this self-protection process. In fact, it is obvious that the ongoing deep and general transformation of man and societies evokes and tends to produce new ways of thinking and acting. Similar processes have been observed worldwide all along the historical evolution of societies and their cultures.

The progress of systems thinking

A significant evolution during the 10 to 15 more recent years has been the nascent and/or growing interest in systems thinking in countries where it was practically unknown, or at least undeveloped.

In Europe for instance, very useful work has been produced in Belgium, the Czech Republic, Denmark, Finland, Greece, Poland, Russia, Slovenia and Switzerland, in addition to what is done since many years in Austria, France, Germany, Hungary, Italy, the Netherlands, Spain, Sweden and the United Kingdom.

Meanwhile Canada and the United States remain fully active.

Another very important development is presently taking place in China, Korea and Japan, where significant correspondances are discovered with the traditional oriental philosophies.

Latin America is also waking up. The oldest systems society, the argentinian, is now in good company with the active peruvian one and more informal groups in Brasil, Chile, Colombia, Mexico and Venezuela.

Signs of activity have also been registered in Australia, New Zealand and South Africa. In all these countries original work is produced and interest is growing.

In short, we seem to be on our way toward a worldwide awakening.

Now only Central and North Africa, the Middle East, Central Asia, India and Indonesia remain largely absent

The foregoing "stock taking" could indicate that we are slowly nearing the critical mass needed if systems and cybernetics were to be recognized as useful mental and practical tools.

The Road ahead

Of course, we still need to fulfil some basic conditions before reaching such a stage in our progress.

1) Concepts and models must be translated into specific methodologies for design and action in administration, business, ecological and social issues, and politics. What has already been achieved must be diffused much wider.

The United Nations and specially UNESCO would have to play an active role in such translation and diffusion of the results.

Unesco already made a good start with the edition of the small but substantial books on education by Edgar MORIN and the publication of the "Encyclopedia of Life Support Systems" (EOLSS), whose conceptual foundation is systemic.

The Union of International Associations (Brussels) possibly could still expand its valuable Encyclopedia of World Problems and Resources, which structural organization is also quite systemic.

2- All that has been gathered until now in systemics and cybernetics must be transmitted to the new generations, who will need it still much more than their predecessors.

If this is not done, they would lose critical years to rediscover an already existing knowledge, ready for use, and on which they could start creative work of their own.

3- The already disponible information should be ordered and made available in more easy and convenient ways.

The quite limited diffusion of the systemic and cybernetic journals (some of which have even perished) is completely insufficient.

Much more should be done, particularly by creating a general repository of all existing past and present material. And of course, the www. should be used in a much more extensive (but precise) way.

Moreover, notwithstanding the fact that english is now the "lingua franca" of communication, the information needs of non-english speakers or readers should be taken care of.

As conversation and creative debate at all levels and places are essential, adequate basic material should be produced in the most important languages: arabic, chinese, french, german, italian, japanese, portuguese, russian and spanish. Ideally the list should also include bulgarian, hindi, hungarian, iranian, kiswahili, malay, polish, rumanian, turkish and urdu.

The International Federation for Systems Research (IFSR) could play an important role, helping those who would like to translate significant papers and books into their own language, or produce original information of general scope.

In this Encyclopedia's second edition, at least much more references in french, german, italian and other languages have been included.

But anyhow this will be useful only for those able to read this book in english, to begin with.

On the other hand, the inordinate proliferation of information and particularly doctored pseudo-information that characterizes our present time is now a problem in itself. Until-let us say- 1950 lack of information was the main hindrance.

On the contrary nowadays we are in danger to drown in a deluge of propaganda of the most various intentions, as well as proposed "good for all" models or pseudo-models offered by so-called "gurus".

From one side, our disponible time to gather information is strictly limited. We are thus obliged to select those inputs that are really significant and seem potentially useful to us. This is in itself a time consuming process.

We need also to adapt and readapt more and more frequently to shifting conditions in general and in our specific field of activity. As said by Gerrit BROEKSTRA, "no fit is forever". He could have added..."not even for long time".

Conclusions

Accordingly, Systems thinking does not offer recipes for "solutions". What it proposes is a methodological approach that help us to conduce our thoughts in an ordered, renovated and more efficient way when confronted with new issues that are much more intricated and wide-embracing than even in a recent past.

In short, we must reconstruct our own mental and psychological competence if we are to assume efficient and personal responsibility in our behavior and decision making. If not, we would merely contribute to the growing general disorder and evermore turn into helpless social puppets. This is indeed also becoming true for the very puppeteers who believe that they all-pervasively control our strings. In fact we have frequently seen their power slowly eroded, if not suddenly destroyed by the unexpected reactions (for them!) of the social groups or systems that they fancied themselves to manage at will. This was the final fate of nearly all of the major political leaders during the last century.

As a conclusion, preparing this second edition has been for me a constant process of self-critical thinking. I had to evaluate in a recursive way what was significant, and how, and why, and applicable to what and when... and also what is connected to what else and in which stable or transient way. Moreover, integrating new ideas to the already existing material was frequently an arduous process.

Finally, the global result is again merely offered as "food for thought", but now also more intended as tools for reflexive and responsible intervention in better understood situations and issues.

I must once again tribute my gratitude to the many friends who helped me in a way or another to prepare this updating; to the valuable support of the International Federation for Systems Research, to my patient publisher, and once more to my wife Gloria in her triple quality of librarian, typist and generously understanding spouse.

Charles François, June 2004

INTRODUCTION

"Socrates complained about writing. He felt it forced one to follow an argument rather than participate in it, and he disliked both its alienation and its persistence. He was unsettled by the idea that a manuscript traveled without the author, with whom no argument was possible. Worse, the author could die and never be talked away from the position taken in the writing" (Alan C. KAY, *Sc. American*, sept. 1991)

"It is the confusion of (the) different meanings that causes an intolerable babel ruling out any possibility of the strict explication of appropriate concepts. We believe that the way out lies in singling out that part of the content of these concepts which makes them specifically systemic ones, and in carrying out the necessary systematization on this basis" (I. BLAUBERG et al., 1977, p.287")

My first motive to start compiling a "Encyclopedia of Systemics and Cybernetics" has been grounded in my own doubts about various aspects of these new approaches, as reflected in the writings of numerous authors.

To begin with: Why did they appear and why did they so during the second half of this century?

We can perhaps go back to the founding fathers. Ludwig von BERTALANFFY was obviously wondering why very similar concepts and models were appearing independently in many different disciplines. And which was the basic nature, of such similarities? It seemed that some common substrate existed and, being this the case, that it could be useful for creating valuable synthesis and short-cuts in a number of disciplines.

BERTALANFFY never stated very clearly that all "systems" have in common their complexity, which is different and much more than complication, because it reflects some basic and coordinated types of internal organization and interesting similarities in the basic nature of external contexts, whatever their particular nature. He did however perceived these general features as the common basis for his inquiry.

As to Norbert WIENER - particularly inclined to mathematics and engineering - he observed the seemingly universal character of some specific relationships, that could be modeled through similar mechanisms in very different kinds of systems. He thus introduced feedback, leading to the basic notions of "Control and Communication in the Animal and the Machine". It became immediately clear that the feedback relation implied a closing loop, leading to nonlinearities and complex devices, that could be found in natural organisms or created to steer artifacts.

It is now confirmed that "complexity" is the master-concept. Emergence of complexity:

- 1) paralleled the emergence of a better perception of complex systems in nature (Living beings, ecosystems, animal societies) and man-made (in business, economical, social, political).
- 2) led to the dawn of our understanding of the intricate character of natural entities, either closely packed (a plant, an animal) or loosely interconnected (biota).

I have in this way been driven to the conclusion that Systemics and Cybernetics were interconnected and adaptive responses to complexity, either newly built in artefacts, or newly perceived in nature.

A serious problem for me, and probably for most of the would-be users of these new approaches has been the piecemeal appearance of numerous concepts and models, all somehow referred to complex entities, but in a haphazard and unconnected way. In effect, many systemic concepts have been elaborated under various guises and from different viewpoints by a number of systemists, or even by non-systemists. In some cases the correspondences are less than obvious, and many are probably yet to be discovered.

For example, as an afterthought, feedback seemed to be somehow related to dissipative structuration and hierarchies; variety to control; information to entropy; entropy to dissipative structuration; information to variety; etc... But these "somehow" should better be explained!

Many authors brought in numerous new notions, but it seemed to me quite difficult to find the significant linkages between them all. While, after all, a science of complexity must necessarily be complex itself, the crux of the matter is to discover a meaningful conceptual structure for the whole, if any.

Another very serious problem is that even nowadays, most self-styled "systemists" are interested in Systemics and/or Cybernetics only within the limits of their own disciplinary activity. This is understandable, but by doing so, they cut themselves out from the main and most important meanings of the new approach:

- a) a general understanding of their personal location within global science and global society;
- b) the emergence of a meta-language opening the real possibility for conversation, and most important, for true transdisciplinary conversation.

Such metalanguage is now a much needed tool to compensate for the growing Tower of Babel syndrome which is a very unfortunate result of the evermore reduced and particularist scope

of an ever growing number of very specialized disciplines, whose increasing isolation was already denounced many years ago by Kenneth BOULDING.

It must however be recognized that the systemic movement still suffers from chronic un-systemism also denounced many years ago by Margaret MEAD, at the time President of the S.G.S.R. ("Who shall systemize the systemists?"). There exists practically no global overview of the whole field, even if some quite synthetic theories have been proposed (MILLER, HAKEN, SABELLI, Mc NEILL, for instance).

It seemed of utmost importance to try to put together a kind of encyclopedia about the systemic approach, embracing as much information as possible in order to:

- create an introductory compendium and source book for any interested newcomer
- put information until now widely scattered in time and space at disposal of seasoned systemists.
- open the field as a whole to comparative and creative debate.

Accordingly, the three basic aims of the encyclopedia are to define (when possible and useful); to comment and discuss; and to interconnect systemic and cybernetic concepts, models and meanings. This last aspect is properly the systemic one.

Practical realism has been another important motive to tackle this work. I had to see myself with many critical real life situations, including war, civil strife, decolonization, transcontinental emigration, authoritarian regimes, learning new languages and trades, enduring painful personal losses, etc...

I am also very much afraid that the present slide towards a general and worldwide crisis of civilization has still to reach its nadir - perhaps with a global ecological crisis in a still more or less distant future: 50, or 100 years?

Meanwhile, the present situation is characterized by a piecemeal approach to all complex situations, generally commanded by short-term political or economic expediency, if not downright by strictly limited personal goals (many times non-sancti). This is a trap from which escape will prove very difficult, and probably impossible without previous vastly-embracing "educative" catastrophes. If and when these occur, the short-term and narrow view will prove useless and the systemic understanding could become a decisive factor, if clear-minded and very courageous people happen to be at hand. Our present responsibility is to handle over "food for thought" to the new generations.

Accordingly, I feel it very important that systemics and cybernetics as a new "Weltanschauung" should as quickly as possible ex-

pand out of Academe. We - i.e. all of us - will evermore need good models of complex situations, that cannot anymore be understood, evaluated and amended by the exclusive use of our present linear and reductionist models. Some examples of such situations are: underdevelopment; the universal squandering of resources; the worldwide spread of unemployment; the hothouse effect; the new paludism and tuberculosis crisis and the AIDS one; the general ageing of populations; the growing cost of technified science, particularly medicine; the ethics of genetic engineering; etc, etc...

Accordingly, this encyclopedia also aims at transmitting systemic-cybernetic models and concepts to Jane and John Citizen, who need them urgently, and most of all to their children and children's children, who are going to inherit our blunders and our sins.

Consequently, I am impatient with esoterism in Systemics and Cybernetics. We need to be understandable if we want our models and methods to reach the decision makers who really could use them and probably will need them urgently in the coming years. They specially include spiritual and institutional leaders, managers, politicians, and educators.

I thus personally deplore the multiplication of terminology derived from the old Greek language: "Autopoiesis", "Homeostasis", "Isomorphy", "Stigmergy" and the like, which could have perfectly well been replaced with plain English wording: "Self-reproduction", "Stability within limits", "Total similarity", "Transmission through environmental context". Accordingly, I introduced and discussed such terms only because they bear real significance or are widely used as a kind of shorthand, while no plain English substitutes are known.

After 40 years of learning and thinking on systems, I still discover new aspects and insights into the systemic perspective. I have slowly reached the conclusion through personal experience that Systemics is the most important mental and psychical mutation since at least the Renaissance, and possible the Presocratic philosophers and, in a worldwide perspective, since Buddhism, as a philosophy, and Chinese Confucianism and Taoism.

Also, after 60 years of being in four continents a more or less willing or unwilling actor and/or witness of this troubled finishing millennium, I must conclude that mankind is still far from the point where a sufficient number of people will acquire a reasonable non-magical and non-ideological understanding of the world they live in, even if general information and consciousness have very much progressed nearly everywhere since 1940.

Insofar as Systemics may further such understanding, and as much as my best ability will allow me, I feel a responsibility to cooperate to this progress.

Personal limitations

This work has been prepared in Argentina by a French-speaking Belgian citizen, who never lived permanently in any English-speaking country. This implies some limitations... but also some advantages.

Nearly nowhere in South America is it possible to find any printed material on systems and cybernetics in English (and even in Spanish, very few translations are available). As a result, I depended basically on what I was able to find out for myself in Europe and the States, or on what important systemists leaders, or personal friends have been kind enough to supply me, as for example a photocopy of some specific out of print work!

As a former and now retired officer of the Belgian Foreign Service, I was also never a member of any university or college staff. Consequently, I had, and have still now, to cover personally all expenses related to Systemics and Cybernetics, as for instance subscriptions to journals (which are becoming evermore costly), participation to meetings, travels, etc. This has been a sometimes severe limitation.

While most of my sources are the original ones, I also had to rely on quotations, or on translations (for example from Russian), or even worse, retranlations, when the original was unavailable, out of print or out of my reach. This has been signaled in every case. I translated myself numerous quotations from French authors, as well as a lesser number of others from Dutch, German, Italian and Spanish. In every case, a considerable effort was made to reproduce the original meanings as best as possible.

Moreover, I am well aware that a given source may not be the original one, nor possibly the most up to date. I simply used either the best (in my opinion) to my knowledge, or the best one at hand. In some cases I did not return to the original authors, using instead some clear and synthetic summary by a recent author, who sometimes clarifies a subject better than the original author, who can be obscure or esoteric, or as Socrates feared, alas not anymore able to follow any "argument".

I did not introduce in the encyclopedia logical and mathematical formalisms for various reasons. The first one is that I do not feel really qualified to enter with any depth in this particular aspect of Systemics and Cybernetics. It is to be hoped that some other author will in a near future tackle the difficult task to gather and interconnect the works in this field by authors like LØFGREN, RENYI, VALLÉE, DUBOIS and many others.

There are also other reasons for not entering in formalisms:

- It seems more useful for the time being to try to explain the whole subject in terms understandable by lay people;

- It would be better for anybody interested in formalisms to go to the original sources, which I have tried to indicate in every opportunity.

To whom this work is addressed

Paraphrasing POPPER on rational arguments, it could be said that people will not be moved by systemic arguments until they adopt a systemic attitude. This is of course a tall order.

It seems however decisive that any interested person should be able to find basic understandable information, collected in such a way as to avoid a very long and uncertain search in an enormous - but still probably quite incomplete - stack of scattered sources.

Accordingly, the general aim of the encyclopedia is to offer a tentative frame of reference for anyone interested. Anyhow, in Ernst JÜNGER words: "We cannot give *the* solution, as any solution is true only for who encountered it" (In his novel "Heliopolis", French translation, p.362).

Some items in the encyclopedia are quite elemental, others less so. As I see no reason why Systemics should remain restricted to higher level learning, my hope is that the work should even prove accessible at least partly at high school level for those young students who should become interested in the subject, or to any other intelligent person.

However, unfortunately but also inevitably, all that entered under the headings in the encyclopedia will not be immediately crystal clear for any user, even if great efforts have been made toward maximum transparency. Some notions are really difficult to grasp at the beginning. I myself needed many years to obtain a reasonable command of the whole subject, admittedly and partly because it slowly came of age during my own lifetime.

It is even possible that some concepts or models which presently appear to be significant could be seen as trivial or dubious in the future: in such kind of work, some risks must inevitably be taken.

Basics: What does Systemics means

The really fundamental meaning and usefulness of Systemics is the acquisition of a new (but complementary) way to look more globally at the world, i.e. J. de ROSNAY's "Macro-scope".

The mere use of some systems concepts or models applied to any specific situation is generally useful. But this should be only a very partial and insufficient response to the real challenge, which is the fabulous increase of complexity and the multiplication of complex situa-

tions that urgently demand a most global synthesis capability for understanding, forecasting, planning and coherent action.

Systemics, combined with Cybernetics, offers a holographic view of the real world, i.e. every systemic concept contains implicitly significant aspects of some or many other ones.

Only a more or less extended set of systemic models and/or concepts contains the essential of Systemics. However a start can be made through the serious pondering of any of them. Purely scholastic or reductionist exclusiveness is thus blocking systemic thinking and is anti-nomic to its essence.

Systemics implies a willingness to explore analogies and metaphors, in a critical but positive spirit. Many analogies and metaphors, specially most popular ones, reflects the perception by their users of some subjacent general rule, process or structure, worth of further inquiry. This is one reason why this work is more than a simple collection of definitions.

Donald McNEIL complains that, 45 years after von BERTALANFFY's first statements, we still have no General Systems Theory.

One critical question is precisely: Does a really all embracing General Systems Theory exist? And if not, should it? And under which guise?

My - different - purpose has been to create a kind of conceptual hologram of the whole field, as it is now. This is of course no General Systems Theory. However, looking at the hologram from any angle, systems concepts will appear in a connected way, revealing I hope, the general "skeleton" (in BOULDING's words) of which a genuine General Systems Theory could - or not - emerge and become clearly visible (see D. McNEIL, 1993b)

Another bone of contention is so-called "Systems Science". In John WARFIELD's words: "Unfortunately, there is a considerable confusion about what constitutes systems science, even among people who choose to identify themselves with systems-related areas" (in "Economy and Systems Science", 1990, p.67).

The encyclopedia does not pretend to rigorously define what "Systems Science(s)" is supposed to be, or not. It tries to collect as many as possible concepts and models related to complexity, most of which appeared in specialized disciplines without any clear a priori understanding of their general value. Examples are: Punctuated Equilibrium in paleontology; Stigmergy in entomology; or Hexagonal space filling in human establishments. Some of these are even now totally ignored by most systemists who, as a result, are unable to consider them as possible general models or concepts, fit to describe and, if possible, explain a number of situations in a number of different fields.

In any case, global or total knowledge is now impossible at the individual level. It should be replaced by as global as possible collective coherence in acquired knowledge, through conversation (which is in itself a systemic tool - G.PASK).

Outside her/his own professional specialization, a systemist is always treading a mine field when she/he refers her/himself to some really specific research. However, one of her/his most significant role is to create conceptual interrelations. This is not easy and, accordingly, one must more than once use prudent qualifications as for example "possibly", "probably", "could", "should", "seems to", etc...

This is the price to pay for advancing some speculations that may be stimulating and potentially useful.

Another point is that it is self-defeating, ill-advised and finally useless to try simply to convince specialists to become generalists. Specialists know best about their own work, which moreover is necessary and of utmost practical importance. This fact should be recognized once and for all, in order to eliminate a needless cause of controversy. The real point is to interconnect specialists and provide them with a meta-language or lingua franca in order to make them able to tackle *global* and *complex* situations, in collaboration with non specialized people, mainly managers, administrators and politicians, who also need systemic concepts and models in their own right.

The historical triumph of reductionism, manifest in our everyday life, led to a narrow technocracy, which tends regularly to micro quick fixes and empirical tinkering, or even brushing the problems under the carpet.

Many systemists should however share the blame, as their response has been too frequently a short-sighted, hostile and superficial critique of "reductionism". We should return to a 1984 paper in which L. TRONCALE established a list of performance criteria for "General Theory of Systems" (not "Theory of General Systems"), which unfortunately has been widely ignored.

From another perspective, it appeared to me with growing evidence that it is not possible to construct a systemic-cybernetic language without constant reference to the general conditions of existence of *any* language. This explains the presence and emphasis in the encyclopedia on semiotics (PEIRCE, ECO), general semantics (KORZYBSKI) and generally many psychological references to forms of learning; acquisition of meanings; to meanings of meanings and to their representations (WHITEHEAD, RUSSELL, BATESON, PIAGET, WATZLAWICK, von FOERSTER, von GLASERSFELD, etc.)

For similar reasons, systemic epistemology has been given wide attention, as it seems basic in order to stabilize Systemics as a scientific methodology. Accordingly, along the formerly

quoted authors, BUNGE, GÖDEL, van GIGCH, ROSEN, WARFIELD, and others have been given serious coverage, even if some of them are, or were, not specifically known as practican systemists.

Generally, the meaning of most of the formal mathematical and logical basements of systemics are still somewhat enigmatic. This is the case with fractals and self-similarities, cellular automata and self-reproduction, fuzziness, catastrophes, chaos, dissipative structuration, GÖDEL's incompleteness, BREMERMAN's limit, CHAITIN's algorithmic incompressibility, HEISENBERG's indeterminism, etc... As commented by John CASTI: "Ascertaining the exact nature of the relationship between a real world phenomenon and a mathematical model of that phenomenon is probably the most fundamental problem in theoretical science" (1984, p.282).

On the other hand, Systemics and Cybernetics are still widely in a state of flux. It is therefore difficult, and even possibly unsuitable at the time being, to fix them very well defined boundaries. As discovered by this compiler during his evaluation work, systemic-cybernetic semantics, epistemology and ontology are still in process of formation. Some concepts or models have somewhat fuzzy meanings (for example, "Preadaptation"). Some others seem to overlap (somewhat, or much). Some other ones are not, or not yet really general, or did not yet become fused with some other ones of general meaning ("Catabolism"?). These are good reasons to remain flexible.

One of the main aims of the work is to contribute to what John WARFIELD calls "referential transparency", here in Systemics and Cybernetics. This is no mean task, and I do not fancy to have it completed. However I have gathered a considerable number of elements that will probably be useful in order to come closer to transparency. In any case, a deeper understanding of some very important concepts, as for example those enounced by von NEUMANN, ASHBY, von FOERSTER, PRIGOGINE, MATURANA, to cite only some, is a must. The spirit of the work is to incite the user to go to the sources.

D. McNEIL rightly observed that an encyclopedia, specially an alphabetic one, cannot be a substitute to an integrated view of Systemics. This seems correct to me even if I tried to emphasize global views by cross-referencing and clustering. I hope that the present work could at least be a stepping stone:

- for those who want to acquire a basic understanding of the systemic approach;
- for anyone who would wish to attempt for her/himself LASZLO's "Great synthesis", i.e. not merely adding some specific view on systems.

My view is that the encyclopedia should be a linguistic and semantic system in the sense of de SAUSSURE: "An organized totality, made of

solidary elements, that can be defined only reciprocally in relation to their place in the totality". Only a frequent and critical use of such a language can produce a reasonable understanding of the ways meanings are interconnected or correlated.

Synthesis, as understood here is not a limiting or purely classifying one, but on the contrary, an open one, a multi-combinatory one. While the language as a whole acts as a global determinant, it allows also for a limitless open space for present and future variations: those produced by myself, and all those triggered in every user's mind.

In every case, I strenuously strived for clarity. No single quoted item entered the work without having been pondered. When necessary, comments and critique have been added, hoping to better the understanding of any notion that would possibly seem obscure for the reader. However, again, nothing can replace reference to the original authors.

Finally, I have tried to give a voice to as many people as possible, including many non-anglo-saxon authors, while still respecting the preeminence of the main concepts.

I tried also to interconnect various streams in the field by sometimes using information from less well known sources, as well as some frequently left aside because of language, or geographical, or simply diffusion problems. Examples are the Namur triennial International Congresses of the International Association of Cybernetics, or the works of the Systeem Groep Nederland.

Conceptual contents

Before taking any decision about anything, we need to acquire an as good as possible knowledge of the system about whose future we want to decide, the conditions that may influence it, and have an idea of its possible futures. In P. ALLEN's words: "... the necessary precondition to a discussion of policy is to have a model", and such a model, as a rule, must be dynamic and nonlinear.

Accordingly, what *practically* matters in Systemics and Cybernetics is the combined use of concepts, analogies, homomorphies and isomorphies to construct complex models of concrete systems.

In consequence, I adopted a quite extended and many-sided view of the work's content.

Many not well known terms have been included, in accordance with the following criteria:

- that the term really introduces some significant systemic meaning, or at least some specific shade of meaning, for ex. H. PRAT's "aura", or P. GRASSÉ's "stigmergy";
- that it has been at least sometimes used in the literature, for ex. R. GERARD's "artorg" or L. TRONCALE's "discinyum".

- that some significant relation to systemic situations could be found, as for ex. through G. CHAITIN's "algorithmic compressibility".

From another perspective, strictly speaking, a more or less limited systemic definition of "organization", for ex., could be given. However, many systemists offered complementary views on organization (ACKOFF, BEER, BOULDING, BROEKSTRA, LEMOIGNE, MILLER, SIMON, VAR-ELA, etc...) and this multi-dimensional perspective is so rich that it cannot be ignored in a work that tries to reflect as best as possible the wide content of Systemics.

It has also been taken into account that, between 1954 and 1997, a slow shift in systems terminology has taken place, as a commendable result of a progressive improvement of systems semantics, elimination of ambiguities, or even misleading uses of the original terminology: the differences between models of an isolated, a closed and an open system, or the precise meaning of "positive" feedback, are examples.

Some items of a seemingly very specific or specialized character have also been introduced (for example: "monoculture" - from Unesco-Unep Glossary) because of their general importance in systemic situations. On one side, this connects valuable information of special character to the mainstream of Systemics, with interesting generalizing possibilities. On the other hand, it may lead specialists to a better connected understanding of their own field.

Some terms were included:

- because it seemed useful to seek their meaning in the systemic perspective. This has been specially the case of some human sciences terms, like "ideology", "norm", or "value".
- as they seem to carry a potential for a general systemic meaning: "swarm", "symbiogenesis" or "Umweltlehre" are examples.
- mainly because they lead to a better understanding of the practical meaning and use of their *implicit* (and sometimes even enigmatic) systemic significance: "ethnocentrism", "parable of the boiled frog", or "Saint Matthews principle".
- for their practical value, as for example: "disasters: a systemic view", "patrimonial accounting", "perverse effects".
- because, while closely related to a specific discipline, their more general systemic nature, aspects or character are becoming more and more obvious: "anabolism", "autokinesis", or "catalysis".
- because of their relevance to Systemics for some particular reason: "Club of Rome", as a user of Systems Dynamics; "culture" as interpreted in systemic terms; "Dictyostelium discoideum", as a biological example of self-organization and sociogenesis.

A number of terms in the encyclopedia are related to para-systemic, or even anti-systemic views. They have been introduced for reasons of epistemological clarification, as it should be very difficult to understand some aspects of Systemics without the background of non-systemic situations or attitudes as "linearity", "reification" or "reductionism".

Some other terms have definite systemic and, simultaneously some non-systemic meanings, whose limits must be considered. An example is "memory".

A number of more or less technical terms were introduced because they are systemic in an implicit way or could be considered from a systemic viewpoint, even if many practitioners are working in a non-systemic style. Examples are: "research and development", "risk analysis", "sustainable development".

Some other terms, as for example "forecast", or "prospective", are used as stepping stones to define a systemic way of research and inquiry into the topic.

More items were incorporated, not so much for their intrinsic specialized interest (which may be considerable), but for their general systemic significance: "hysteresis", "Kondratiev cycle", "semiology", "thermodynamics", etc...

Considering their importance as modelization tools, logical and mathematical concepts related to Systemics have been presented, at least in general terms: "Boolean nets", "catastrophes", "chaos", "graphs", "KAM theorems", "neural nets", "topology", and others.

Superpositions in terminology have been discussed. Frequently different authors converge toward a systemic phenomenon through different ways. For example, the shaping of a system on a higher level of organization is termed by LASZLO as "emergence", by TURCHIN as "meta-system transition", by PRIGOGINE as "nucleation at bifurcation points through dissipative structuration", by researchers on networks as "spontaneous organization", etc... None of these concepts should be left out, as they give a kind of holographic view of various aspects of this type of phenomena. Even J. MILLER's taxonomy of living systems can be viewed as a photograph of the results of emergence.

Consequently, the encyclopedia is somewhat redundant, and intentionally so, as it is not possible to assimilate any systemic set of concepts without viewing these again and again from different but more or less interrelated viewpoints. It is hoped that this feature will help to the globally interconnected understanding of our subject as a coherent whole network of concepts and models.

Some users will possibly think - or even say or write - that this work is a very mixed bag. This may be true, but so is that hypercomplex world that we have constructed and in which we must live, using models and concepts as

different as the golden proportion, quanta theory, chaos, or organizational closure in perceptual and psychological terms.

Many examples are given, in order to avoid a purely abstract and theoretical character that could hinder the practical (and very much needed) uses of Systemics. In effect, as I believe that the systems approach and systems methodology are first rate tools to confront present and future complex challenges, I am critical of some tendencies that could exert a negative influence on their diffusion: excesses of superfluous abstract formalisms; exaggerated claims to a superficial universalism; unwarranted attacks against specialization; tendency to use jargon, etc...

A final caveat about the evaluation of concepts seems necessary. In my own comments, I have tried to avoid *loaded* adjectives like: "correct", "convenient", "desirable", "legitimate", "reasonable", "satisfying", "valid", and the like (or their opposites) as such notions correspond to implicit personal or socio-cultural criteria that may not be universally admitted. When quoted authors use such qualifications, which have been respected, their dubious character should always be remembered.

This is not to say that I believe in the practical possibility of absolute objectivity. But I would at least like that any user should stop in his/her tracks everytime these words appear, and think for a moment about their relative personal, social and cultural meaning.

Linguistics and Semantics

We should now turn back to the Tower of Babel syndrome. As noted by John WARFIELD, establishing a satisfactory conceptual language has been in the past the condition for the success of many scientific disciplines. This was done for example by LAVOISIER for inorganic chemistry; KEKULE for organic chemistry; MENDEL and FISCHER for genetics; LEIBNIZ and BOOLE for logic; CRICK and WATSON for biochemistry; WEGENER for plate tectonics; and quite recently by PRIGOGINE for generalized thermodynamics.

Precisely, one of the problems of the systems movement is the persistently scattered character of its language, which has remained ill-connected, confuse and fragmented. Accordingly, the main objective of the present work is to correlate and unify the language of Systemics and Cybernetics, in order to transform it into an efficient tool for the study of complexity, for beginners as well as for advanced researchers.

Margaret BODEN writes: "The 'meaning' of an idea represented within a semantic net is a function of its place in the system" (1990, p.95). This is a very neat formulation of my own general concept of this encyclopedia as a network. Three aspects should be emphasized:

- Language is always a mirror for the mind and the culture. But it is not always a *faithful* one;
- Every item has a potential for multiple linkages (TRONCALE), each of which adds - or restraints - some shade of meaning;
- Semantics is also a process: the network becomes more useful and efficient when used. The encyclopedia offers a connectionist aspect, as it invites to "ramble" freely within the whole systemic and cybernetic conceptual space. It also proposes a constructivist way of use, as such a free rambling must normally lead to the progressive construction in the mind of any individual user of her/his own semantic net.

In a converging way, every concept becomes more like an attractor or the center of a semantic cluster, including what Margaret BODEN calls a "penumbra" of more or less closely related concepts (1990, p.96, 175).

There is some degree of redundancy in the whole of the work. This allows for a multidimensional view of these interconnected concepts. "Connection", for instance is not exactly or merely a "relationship". Moreover, it acquires a slightly different meaning in "connectionism" or in "connection machine". This is a useful feature to obtain a deeper understanding of the systemic language.

Some doubts should also be clearly stated.

A number of terms of frequent use have, in common language, a somewhat fuzzy character. Examples are: "action", "change", "class", "concept", "description", "effect", "learning", "object", "problem", "representation", or "situation".

These apparently quite universal and taken for granted terms should not be passed by without a short pause to remember that their meaning(s) should be pondered, as they can be less transparent than frequently believed.

In values - or norms- loaded words, there exists a kind of "semantic declination", comparable with the "magnetic" one. A non-systemic term like "democracy", for example means something quite variable according to countries and cultures. This may even be the case with a supposedly rational concept, as for example "order", or "organization". Here again we have a case for a reflexive pause.

Finally, I was not always convinced that some terms used by some systemists had really a systemic meaning. They could even in some cases be considered as contaminants in the systemic language. Not a few have however been included, generally with a critical evaluation, whose responsibility is assumed. The user should decide for her/himself.

In any case it seems better to remain open and tolerant.

I tried to alleviate as much as possible some practical linguistic problems.

In some cases, quotations from authors reproduce some combersome redaction. The original has always been reproduced without modifications, in order to strictly respect the authors work. Only in some serious cases have critical observations been made.

Most quotations are from the original texts. However in some infrequent cases, due to the unavailability of originals (out of print, out of reach), I had to retranslate to English from a translation in Spanish, French or German. This is not of course a very satisfactory method.

In some few cases, however, available original texts were not used because recent authors presented a specially clear and synthetic overview of a difficult concept. An example is K. DE GREENE crystal clear explanation of HAKEN's "order parameter" concept.

The whole work has been redacted in American English, with the exception of quotes from British or European authors, who may have used U.K. English, a feature that was respected. This is the reason why it is possible to find two different spellings in the encyclopedia, as for example "behaviour" or "behavior".

Jargon has been avoided as much as possible, as well as unnecessary (in my opinion!) abstractions: both act as a strong repellent against many potentially interested users. On the contrary, many examples and comments, some of them very close to popular common sense have been used.

The fuzzy limits of the work

What should be included and what should be rejected in such a work? There are two complementary dangers: to be too tolerant with seemingly senseless or totally redundant terminology... or to be too intolerant.

This problem has already been encountered for example in relation to biological terms ("anabolism", etc...), introduced because of a possible generalization in systemic terms that could be duly established in the future. The same difficulty appears with terminology from artificial intelligence, computer science, ecology, ethology, expert systems, etc... Even some quite general notions, related to the not so rational way we sometimes assess issues and situations, mostly considered as "obvious", have been discussed, because of some new shades of meaning from a systemic viewpoint: "change", "choice", "cost", "efficiency", "goal", "object", for instance. Other similar cases have been considered above. In general, I preferred to err on the tolerant side.

Some more specific items have been included mainly to try a critical evaluation, (as for example R. SHELDRAKE's "morphic fields"), as they may have a systemic outlook, but are not (yet?) consensually accepted in the mainstream systemic thinking.

Furthermore, I suspect that some, or even many systemic concepts and models are still to be discovered. Some mechanisms, used in a specific discipline, could be possibly given a more general character. An example is "apoptosis", a general cellular mechanism of cell self-destruction, also present in the brain of Alzheimer's disease patients. Could such a mechanism be somehow active in other types of social networks? The "stigmergy" concept, introduced in this work, is obviously an example of such possible generalizations, that could be much more than metaphors.

Undoubtly, much work remains to be done in many different directions; this explains why the encyclopedia is interspersed with question marks, an unexpected feature in such a work.

While I always tried to reproduce as fully and as faithfully as possible all authors views and concepts, it remains obvious that it is impossible within the limits of short articles or entries to express all the shades of meaning developed in a paper or in a book. Accordingly, every quoted item has been carefully referenced in order to allow and encourage the user to go to the source.

Basic information has been added on the main systemic organizations in the world.

How the work is ordered and presented

The encyclopedia was constructed by progressive accretion, "reaping" terms corresponding to models and concepts from many and very different sources.

A curious result emerged spontaneously: a number of terms and expressions started to form clusters in the two following ways:

- "Blocks" of concepts corresponding to specific theories, as for example "Catastrophe theory", "Communication", "Thermodynamics of far-from-equilibrium systems", etc. At times some isolated elements came to accrue a cluster (or various ones): "Learning matrixes" obviously are related to learning, but they also introduce insights about the concept and uses of matrixes in general.
- Clusters tended to coalesce around some quite specific notion. Examples are "Control", or "Model".

While related entries are as much as possible clustered, they are not *fused*. It seemed more convenient to neatly individualize different aspects of the same concept in order to encourage due consideration of the corresponding shades of meaning.

Even so, the general ordering of terms remains somewhat arbitrary. For instance, abstract terms describing systems are all listed under "system", as for example "system, multilevel" or "system, stationary". But specific

concrete systems are at their corresponding alphabetic place as: "social system", "socio-technical system".

Generally, in composed expressions (as for example "circadian rhythm"), the alphabetic order chosen in the encyclopedia has been selected taking into account the meaning of the most specific term - in this case "circadian". However a reminder has been introduced at the corresponding place: "Rhythm, circadian".

The fact that such a work should in principle be alphabetic has some negative aspects, as for instance the need to separate items that are co-significant.

It would be advisable for the user to move "back and forth" (M. MARUYAMA, 1994, p.X), within the network of concepts and models in order to avoid unwarranted disconnections. While this may be difficult, the possibility has been created to criss-cross the whole work by using the net of terms printed in bold. It would be interesting in the future to consider a graphical representation of interconnections by linkage graphs (TRONCALE).

Nearly every term defined or concept explained in the encyclopedia is emphasized in bold types, *everytime* it is used. Some few exceptions are terms so basic and frequently used that the use of bold would be pointless: "Concept", "Cybernetics", "System", "Systemics".

The intention in using bold for general cross-referencing is double:

- That the user may know that she/he can find explanatory comments about the term within the work;
- To induce the user to stop and think for a moment when meeting anyone of these terms: "What is really the meaning, (or meanings) of "chaos", "cognition", or "regulation", for instance?"

When, in some cases, some connections between concepts or models are not so obvious, they are specially signaled by a comment of the type: See also "...."

Some terms with a specifically cybernetic or systemic meaning are also printed in bold when used in their everyday common sense, in order to sharpen the attention of the user to some shades of their meaning. examples are: content, class, issue, means, scale, situation, survival, etc...

The use of bold characters is not always closely related to a specific meaning of the emphasized term. The word "group" appears frequently with different significations, which may, or not, be related. In many cases it is useful to ponder the sense given in a specific case in comparison with what one knows about the various possible ones.

Some terms printed in bold do not refer precisely to a specific entry, but to a closely related one. For example: "Combination", or "environmental" are not in the encyclopedia, but "Combinatorics" and "environment" are.

Italics have been used moderately, mostly to emphasize some critical point, or some personal view. When within quotations, they are always the quoted author's ones.

References in Dutch, French, German, Italian, Portuguese and Spanish have been used. When possible, the reference to the original work, or alternately to its translation in English has been added.

The following special markers have been used, in order to enhance the usefulness of the encyclopedia:

- 1) **meaning** "systemic on a wide range", or "general information"
- 2) **meaning** "general abstract or mathematical model", or "methodology"
- 3) **meaning** "epistemological or ontological aspects", or "semantics"
- 4) **meaning** "practical in human sciences"
- 5) **meaning** "more specific or disciplinarian"

Personal views, self-critique and acknowledgments

It seems only fair to admit that a number of personal views have been introduced in this work. For example: "The results of sociotechnical manipulation on any environment should be closely monitored", or: "Metacommunication frames relativize communication. This is a very significant situation, specially when metacommunication remains *implicit* as it is the case in many transcultural situations". No user is supposed to accept such opinions uncritically.

My aim has been to include practical insights into as many issues as possible. In my opinion, Systemics should be connected to complex *concrete* situations whenever possible, because many of their aspects are easily neglected by specialists and from purely technical viewpoints.

While, at a definite moment, one must decide to put a final stop to any work, it is obvious that this kind of work is open-ended. In a sense, this encyclopedia is still a kind of enormous draft, even if quite elaborated. This offers at once some negative and some positive aspects. In cases, sources could be completed or replaced by better ones. Many new information, and even some older one from still unused literature, could be introduced.

My intention is to go on incorporating more information into this work, even after publication, in order to prepare future updatings. I will gladly receive material or serious critique that users would find of possible interest.

On the other hand, being well advanced into my seventies, I would also be pleased to collaborate with quite younger systemists eventually interested in such updatings.

I consider probable that some internal discrepancies, or even errors may still be present in this final version, even after various painstaking revisions. I hope that users will find out for themselves and, hopefully, communicate me their views.

Aknowledgments are, in this case, a very difficult task. In a way, I feel thankful for the whole systemic-cybernetic community, past and present.

More to the point, this work owes much to the members of the Argentine Association for Systems and Cybernetics (or Study Group for Systems, as it is also known), to the members of the Fuschl Group, to the leaders of various international and national societies (American, Austrian, Belgian, British, Dutch, Danish, French, Greek, Italian, Peruvian, Polish, Slovenian, Spanish).

It also owes much to personal systemist friends, who I will not enumerate here because their names appear frequently within the encyclopedia... and because I would be very much afraid to unfairly forget some of them.

Last, but not least, I need to emphasize the considerable support given by my wife, Gloria NAZER, as a professional librarian and generally as a helping hand in readying the whole work.

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0001

ABDUCTION³⁾

The invention of **concepts**, or logical and mathematical conjectures through the shaping of new hypothesis.

The notion – itself abductive – comes from C.S. PEIRCE, who applied it to new concepts emerging in our mind from witnessing unusual or unprecedented **situations** in which neither **induction** nor deduction can be used. J. WARFIELD stresses these differences. According to him, the origin of newly invented concepts remains a mystery. KOESTLER proposed **bisociation** as a **model** for this type of **creativity**, which like all other types is a product of neural and cerebral **networks activity**.

G. KLIR considers the computer as a valuable instrument in the abduction **process**, because it makes it easier to look “for regularities and developing thus empirical **support** for a mathematical conjecture. When the **support** becomes convincing, it is appropriate to try to prove the conjuncture formally” (1991, p.103).

In fact, abduction precedes induction (and still more so, **deduction**). Ch S. PEIRCE observed that “induction has its role not in the forming of hypotheses, but (in certain **fields**) in testing the hypothesis arrived at by abductive inference” (as quoted by P.R. MASANI (1994, p. 45)

MASANI states for example that “statistical **inference** has to be abductive”(Ibid)

0002

ABSTRACTION²⁾

1) “A **representation** in a selected **code**, not directly reproducing the features of its **model**” (J.Z. YOUNG, 1978, p.289)

2) The search for regular **patterns** through **noise**.

As to the first definition, the “selected **code**” is of course a condition for the coherent search for **patterns**.

For G. KLIR, abstraction is: “The **isomorphic transformation** from an interpreted system into the corresponding **general system**” (1991, p.17). The *interpreted* system is already a somehow **homomorphic model** of some **concrete system**. Such **model** can then be generalized (p.73).

R. LILIENFELD quotes the Spanish philosopher J. MARIAS: “Abstract **truths** do not refer to reality”, but to diagrammatic rendering of reality... while “...thinking about the concrete... presents much greater difficulties” and “... disciplines like logic and the theory of **knowledge** would assume a very different appearance if they were to state their **problems**

in all their radicality and amplitude, so that the present forms of these disciplines would be reduced to mere chapters corresponding to particular cases” (MARIAS.1975, p.126-7, quoted in 1979, p.5).

Fuzzy sets and deterministic chaos, for example, now justifies MARIAS' views (which may have implied a critique of premature oversimplifications in social sciences) In the same vein A.G. BARTO observes: “The disposition to reify abstractions is particularly strong when abstractions have been very successful in accounting for **observations**, i.e when **models** based on such abstractions have successfully undergone extensive **validation** testing and have displayed great predictive power” (1978, p.167).

As **pattern-forming** is the progressive recognition of regularities, abstraction is an emergent **phenomenon**.

(See BERTALANFFY's comments on **categories** formation – (1962, p.71-84).

In G. KAMPIS words: “...abstraction narrows down interest from the entirety of a natural system to a *phenomenal domain*. During abstraction, usually some units of investigation are named and a **set** of observables is assigned to the natural system” (1989, p.90).

Abstraction cuts through **complexity** by selecting only some limitedly characterized aspects of the **concrete system** under study, specifically by reducing in the **model** its **degrees of freedom**. Keplerian and Newtonian mechanics, as compared with POINCARÉ's **three bodies problem**, are good examples.

G. BATESON explains thus our need for abstraction: “**Habit** can deal successfully only with propositions which have general or repetitive **truth**, and these are commonly of a relatively high order of abstraction” (1967, p.254).

The basic condition for abstraction is thus the repeated recognition of some identified **signal** in multiple circumstances (See KORZYBSKI's **structural differential**) (1950).

Abstraction can however become a conceptual quagmire: We should never forget WHITEHEAD's caveat about the risks conveyed by misplaced reification of abstract **models**.

Finally a mathematically inspired view on abstraction could also be useful: the replacement of a **set** by another with a diminished level of cardinality, this leads us again to KORZYBSKI's **structural differential** (see fig. under the corresponding article)

0003

ACCESIBILITY¹⁾²⁾⁴⁾

The possibility to reach more or less easily a place in **space**, from another point or place.

Accessibility can be studied by **graphs** modelling the different positions and routes in a specified **space**.

B. HILLIER, who created what he calls “**space syntax**” as a general theory of the social **organization** of **space** (1996), uses it practically to create an accessibility **hierarchy**, for example for a better **organization** of urban **space**.

According to HILLIER, “People use **space** intuitively, much like they use **grammar**”. This is because they have a “preference for easy journeys” (M. HAMER, 1999).

The subject is closely related to **stigmergy**. This hints to a much more general **perception** of “**space syntax**” in animals.

0004

ACCESS TIME⁵⁾

The time needed to retrieve some item of **information** stored in a **data bank** or **network**.

J.von NEUMANN gave the two following definitions of access time in a computer:

“First: The time required to store a number which is already present in some other **part** of the **machine**... – removing the number that the **memory** organ may have been storing before”.

(Observe the dubious metaphorical use of the word “organ”).

“Second: the time required to “repeat” the number stored – upon “questioning – to another **part** of the **machine**” (1958, p.31).

Both types of access time may be different, according to the **processes** involved.

In the **brain** as well, recall **processes** are not instantaneous, as if some specific **channels** have to be retraced in each case.

→ Time (Access) for a generalized meaning.

0005

ACCOMMODATION¹⁾

1.“A system's-**environment interaction** or **process** by which the **environment** satisfies the changing requirements of the system”. (B. BANATHY, 1973, p.85).

2.“A temporary or lasting modification of the **organism's structures** under the influence of external factors” (S. SALTHER, 1989, p.189-208).

These definitions are so different as to be somewhat contradictory. While B. BANATHY sees an **interaction**, SALTHER sees merely a **process** within the system. In the first case it is the system that governs the **process**, while in the second one, it is the **environment**. The **process** is probably *reciprocal*. Evolving **sym-biosis** and **co-evolution** could be examples.

In any case, functional modifications are as important as structural ones.

On the other hand, accommodation relates to *individuals* and does not normally become fixed in the genetic type, as LAMARCK would have had it (had he known the existence of genes): accommodation acts *on* the basic type, but does not modify it.

Accommodation may however become lasting, i.e. lead to **assimilation**, i.e. it may turn into the basis of a permanent **adaptation** at the individual **level**. Later on, for example through ethological **adaptation**, this may become a factor of future **evolution**.

0006

ACCRETION²⁾

A **process** of **growth** by gradual **addition** of **elements**.

In general accretion is governed by some geometric **rule** or **rules** of **space** occupancy, as for example **clustering** by **fractal aggregation**, or **hexagonal space filling**.

In most cases it also results of **dissipative structuration**.

0007

ACCUMULATION¹⁾

The **process** of piling up of some class of **elements** in a system due to a **positive feedback** in its **production**.

When this **process** turns exponential, for the lack of a countervailing **negative feedback**, it may easily destroy the affected system, as for example in **runaway population explosions**. This is due to a double cause:

- internal clogging of the system, whose **functions** become impaired, due to its excessive **density**;
- starvation of the **elements**, deprived of a sufficient **environmental flux** of **resources** to maintain themselves. The death of the starving **elements** within the system, poisons it.

0008

ACCUMULATOR¹⁾

Any device capable of storing some kind of **resource**, creating an available **reserve**.

Stored **resources** can be energetic, material or informative.

Before **storage**, some other **agent** within the system must in most cases put the **resource** in a form suitable for storing. See: "**Input transducer**".

0009

ACT of a system¹⁾

"A system **event** for the occurrence of which no **change** in the system's **environment** is either necessary or sufficient" (R.L. ACKOFF, 1972 a).

R.L. ACKOFF comments: "Acts, therefore, are self-determined **events**, **autonomous changes**. Internal **changes** – in the **states** of a system's **elements** – are both necessary and sufficient to bring about **action**. Much of the **behavior** of human beings is of this type, but

such **behavior** is not restricted to humans. A computer, for example, may have its **states** changed or change the **state** of its **environment** because of its own **program**" (Ibid).

Systems able to 'act' in this sense are **autonomous**, i.e.:

- in P. VENDRYES' terms, able to determine their own **behavior**, up to a point;
- in H. MATURANA and F. VARELA's terms, endowed with **organizational closure**, i. e. able to maintain their **identity** and internal **organization**.

0010

ACTION¹⁾

H. SABELLI defines action as "the product of **energy** in **time**". He adds: "Action exhibits two **asymmetries**; the **energy** potential and the direction of **time**. All actions share the **time dimension**, but differ from each other in at least one (**space**) dimension" (In "**Organización: Estructuras, Sistemas y Procesos**", to be published in "Encyclopedia of Psychiatry", RUIZ ALARCON, 1994) (pers. comm.).

Already in the 17th and 18th Century various European mathematicians "showed that motion and **change** were always achieved in a way that minimizes the "action" of nature. This action is a measure of the momentum and velocity associated with a moving particle and can be generalized in the case of more **complex systems**" (F. DAVID PEAT, 1988, p.54).

This principle of **least action** has reappeared under different guises in various fields, as for example **ZIPF's least effort principle**.

It is related to the internal **organization** of **fields** of forces and with the consequent **straturation** of form.

0011

ACTION AND REACTION

→ **Le Chatelier Principle**

0012

ACTION CHAIN¹⁾⁵⁾

A behavioral sequence triggered by an initial **stimulus** (see: N. Tinbergen, 1965)

Action chains are present already in **complex chemical reactions** (**Belousov-Zhabotinski reaction** is an example)

However, in order of growing **complexity** the following sequences may be given as examples:

In **Biology**: the fertilization act that triggers the creation of a new living being...and the subsequent **developmental process** (the **homeobox**)

In **Ecology**: the emission of biochemical molecules by a tree under attack of a parasite, such as the molecule acts as a **pheromone** that attracts a specific parasite of the parasite

In **Ethology**: the hormonal **stimulation** of birds in spring that triggers the whole sequence of nest building

In **Psychology**: the frustration reaction of someone unable to stage a strong reaction against some offense or aggression and substitutes it by some symbolic gesture (as for example banging a table)

Action chains should also be researched in sociology. They seem to be present in honey bees and in foraging ants for example.

The way the behavioral sequence becomes established and thereafter stabilized and transmitted through biochemical or other **mechanisms** should deserve a general inquiry.

Examples of such **mechanisms** are imprinting and innate **response**, but their **operation** is not yet clearly explained.

0013

ACTION (Ecology of)¹⁾⁴⁾

According to E. MORIN, future is not absolutely conditioned by some supposed rigorous historical conditioning. This is a kind of generalized **uncertainty principle**, (1999, p. 65-66), a wide (and even somewhat hyperbolic extension of Heisenberg's **Indeterminacy relation**).

As a result MORIN proposes two principles for an "ecology of action":

1- any action, once carried out, triggers an ongoing and very complex interplay of **interactions** and retroactions (**feedbacks**) A similar idea was already emitted by LEIBNIZ (1646-1716)

2- the ultimate consequences of an action become finally unpredictable

→ **Predictability; Prospective; Surrogate world**

0014

ACTION GRAPHS⁴⁾

"Paper and pencil diagrams of interpersonal exchanges of **energy** (labor), **information** (about self and others, affection, entertainment, practical, social and intellectual skills) and **matter** (money and property)".

These **representations**, created by H. SABELLI, in his **process theory** are applied by him to psychology and psychiatry. ("**Chaos and Society Conference**" – Univ. du Quebec, Hull, Ottawa, 1994).

0015

ACTION LEARNING⁴⁾

"A personal development **programme** where a **group** of people learn by working on real problems interactively and autonomously by questioning and reflecting in order to gain insight and **understanding** and considering how to behave/act in future"(G.S. MWALUKO & T.B. RYAN, 2000, p. 396)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The authors paper is inspired by L. WEINSTEIN's work (1995) but they propose their own systemic method for implementation.

0016

ACTION THEORY ²⁾⁴⁾

In 1970, D. SILVERMAN published a "Theory of organizations". M. JACKSON reproduces in an adapted form the "action theory" proposed by SILVERMAN, as resumed in seven propositions:

- 1- the social and natural sciences have entirely different types of subject matter
- 2- sociology is concerned with **understanding** action rather than observing **behavior**. Action derives from **meaning** attached to social reality
- 3- meanings derive from society, become institutionalized and can be experienced as social **facts**
- 4- while society defines man, man also defines society. Particular constellations of meaning have to be continually reaffirmed
- 5- through their **interactions** men can modify, change and transform social meanings
- 6- **explanations** of human actions must take account of the meanings of those involved in the social **construction** of reality
- 7- positivist explanations asserting that action is determined.

This is basically a non-mechanistic approach.

JACKSON observes that SILVERMAN's views are widely interpreted as an alternative, critical of **systems thinking**: "following SILVERMAN's lead (many **management** theorists)...explored phenomenological, ethnomethodological, marxist and, eventually, postmodern approaches to organizational **analysis** without recognizing that systems thinkers were engaged in a similar exploration in their own discipline, albeit with practical action as the primary concern (CHECKLAND 1994, GALLIERS, JACKSON and MINGERS, 1997). In return, it must be said, systems thinkers largely ignored what was going on in organization theory" (Ibid, p. 65-66)

→ **Autopoietic systems; Consensus; Conversation; Observer; Social system (Human); Social order parameters; Stigmergy**

0017

ACTIVATION ENERGY ^{1) - 2) - 5)}

The energy needed to start a **reaction**.

This notion comes from chemistry: A certain minimum **energy** is needed to prime any **reaction**, which may then become self-maintained, or tend to come to a standstill, or run away as in an **explosion process**.

It would be interesting to explore **analogies** in ecology, economy and society. Many **processes** affecting systems in these domains seem to be **triggered** by some more or less

precisely definite **input of energy**. However it also seems that these **phenomena** are very poorly understood and that in some cases disasters may result.

→ "**chain reaction**", "**enthalpy**", "**runaway process**".

0018

ACTIVATION (Forward) ²⁾

The effect of a **feedforward** on a system endowed with a **predictive model** of itself, its **environment**, or both.

In order to avoid any **paradox** about a supposed "influence of the future upon the present", the concepts of **anticipatory behavior**, **feedforward**, **preadaptation**, and **predictive model**, or **predictor** should be carefully pondered. (R. ROSEN, 1967, p.11-23)

0019

ACTIVATION (Spreading) ²⁾

A **pattern of activity** in a **network** that propagates from the input side to the output side, producing a **response** to a **stimulus**.

This **process** takes place in local processing **nodes** inside the **network**.

0020

ACTIVITY of a SYSTEM ^{1) - 2)}

"The ensemble of the variations in **time** of all the quantities under consideration at the given **resolution level**" (G. KLIR, 1965, p.30).

G. KLIR points out: "The **time** interval of the activity is either the entire interval during which we observed the relevant quantities (in the experimental investigation of the system), or the interval in which the variations in **time** are given and are to be realized" (Ibid).

The **distinction between levels** – for instance **micro-**, **macro-**, or **megascopic** – corresponds to the fact that **actions** very limited in **space** and/or **time** (in relation to the defined **observation level**) are **generally** not significant at a higher **level**, because they normally lack the sufficient **range** to have an impact on **processes** of considerably greater **amplitude** and/or much longer **frequency**. It may however be difficult to be sure that any **action** or **event** at a given **level** is not going to make a great difference, as in **chaotic phenomena**.

Indeed, in the proximity of an **instability threshold**, a quite small **action** even at a lower **level** can trigger a decisive **discontinuity** or **bifurcation**.

These quite abstract **models** can seemingly be observed in **concrete systems**, for instance in some ants societies where distributed **processes of task allocations** by **roles** switching have been discovered by D.M GORDON (1995, p.50-7) This seems to take place by a reciprocal and collective needs **assessment** leading to the global activity of the system.

→ "**constructs (synchronous)**"

0021

ACTIVITY PATTERN (Rhythmic) ²⁾⁴⁾

Rhythmic activity patterns can be observed in many natural **phenomena**. Some examples are: Oceanic **waves and tides**; plants **growth**; activity in beehives and, probably, some types of human activities.

According to B. COLE, "... isolated individuals and individuals in sparsely populated **groups** have a pattern of activity-inactivity that is described as **deterministic chaos**. This is not a **random** pattern, but one which is so complex that it is impossible for an **observer** to predict what a particular ant will do next" (in B. GOODWIN, 1998)

Such **complexity** must depend on the **interactions** among individuals, which become reciprocally constraining, but with considerable leeway due to their scattering and the differential **delays** in their reciprocal **perception**.

GOODWIN and colleagues did modelize ants **behavior** through a **neural network of cellular automata** (p.34).

They observed that the **output** of the **network** was **chaotic**. Moreover, "increased **density** of individuals increases the amount of activity by individual, simply because of the higher **frequency of stimulation** between individuals..."

So model ants, behaving chaotically and interacting 'socially' by **stimulation**, can generate a collective rhythm through a **colony**. This is a clear example of **emergent behavior**... " (p.34) And "... the **model** showed that there is in fact a wide **range** over which the **sensitivity** can vary and still produce collective rhythms. This suggests that rhythmic activity patterns are robust consequences of colonial living. They may in fact be hard to avoid. Collective rhythms is an **emergent property** that has been described as "**order for free**" (p.34).

This could be usefully compared with the onset and development of the "**social phase**" in *Dictyostelium discoideum*, and is probably significant in numerous other gregarization **phenomena**.

GOODWIN adds: "There is another important property of colonial rhythms that the **model** revealed. Rhythmic activity emerges suddenly above a **critical density**. But what type of **discontinuity** are we dealing with? The **model** showed that it has the characteristics of what physicists call a **phase transition**: a sudden **change of state** from one type of **order** to another... At the **critical density**, what was a collection of individuals doing their own local thing begins to change as global **order** emerges via activation **waves** that propagate through the entire **colony**" (p.35)

0022

ACTUATION RULE ^{1) - 2)}

A behavioral rule automatically learned from experience by an intelligent system.

This concept is introduced by W. FRITZ (pers. comm.). It corresponds to any **connection machine** able to produce **rules** by progressive **adjustment** and **reinforcement** of a specific **behavior** resulting from repeated similar experiences. A good example is the "NetTalk", an electronic **network** aiming at modelling the **brain's neural network**, which is able to learn to pronounce more and more correctly English words. (J. BRIGGS and F.D. PEAT, 1989)

According to FRITZ, this is also the way people acquire their capacity for organized **behavior**.

→ **Algorithm (Back propagation) and Algorithm (Framing).**

0023

ACTUATOR²⁾

That **part** of the **regulator** which applies the corrective **action** on the **input**.

This term is used by some authors (for example J. MILSUM, 1968, p.41) in lieu of the more common "**effector**".

0024

ADAPTABILITY¹⁾

The capacity of a system (particularly a living one) to **accommodate** its **behavior** to a great **variety** of **situations**.

N. RASHEVSKY observes: "A very important characteristic of an **organismic set** is that, while its **elements** can potentially exhibit a number of **activities** necessary for the preservation of (its) **elements** and of the **set**, in general only a **subset** of the **set** of all potentially possible **activities** is exhibited" (1967, p.22).

RASHEVSKY shows by a biological example that many possible **adaptations** remain latent if not needed, i.e. become actualized only if some **environmental stimulus** awakens them.

Consequently: "The wider the **range** of potentially possible **activities** of an **element** of an **organismic set**, the greater is the **variety** of **environments** in which this **organismic set** can survive" (Ibid)

This is in accordance with ASHBY's concept that only (internal) **variety** can destroy external **variety**.

It is also obvious that, in many **organisms**, if not in all of them, the full **range** of adaptability is never revealed.

On the other hand, as expressed by RASHEVSKY: "The adaptability may be very great but it is always limited. No **set** of genes, no multicellular **organism**, and no society can survive in every conceivable **environment**" (Ibid).

In any case, as observed by E. LASZLO, systems of high **complexity** trade **stability** for richness in adaptability (1972).

0025

ADAPTABILITY (Hierarchically organized)¹⁾

In **complex systems** there are various **levels** of adaptability. In human **social systems** for example, local and specific **adaptations** can be made without **control** or **regulation** from more comprising **levels**, provided they remain within the established **tolerance limits**.

The advantages of such local **autonomies** are obvious, in terms of **resources** as well as **time availability**. It may even be a basic explanation of general **evolution** toward **complexity**, in accordance with SIMON's *Hora and Tempus* famous parable.

0026

ADAPTATION¹⁾

"The process of accomodating to **change**" (UNESCO - UNEP, 1983, p.5)

K. KRIPPENDORFF distinguishes two kinds of adaptation: "a) **Darwinian** adaptation... (through which) **organisms** change their internal **structure** when their **environment** makes existing **forms** no longer viable... e.g. ASHBY's **homeostat**.

"b) **Singerian** adaptation, after SINGER, who described how **organisms**, particularly man, change the nature of their **environment** so as to eliminate threats to, or prevent the destruction of their own internal **organization**" (1986, p.1)

For M. BUNGE: "The word "adaptation" is ambiguous, as it designates at least three different **concepts**, namely the following:

"A1. **Suitability** of a **subsystem**... to a **function** or high value of the **subsystem** for the entire **organism**;

"A2. **Adjustement** of the **organism** to its **environment**

"A3. **Fertility** of a biopopulation" (1979, p. 104)

The three concepts could be easily generalized to **sociosystems** or **technosystems**.

If adaptation is considered a **state**, then the **concept** is tautological: any **organism** demonstrates merely by its actual presence that it is adapted. On the contrary, it should not be here.

Adaptation is not possible without a device that reduces the cost of **regulation**, by modifying the **constraints** within which the system must function in such a way as to reduce the **amplitude** of its **fluctuations**.

As a **process**, adaptation has been described by D.T. CAMPBELL as successive "increases of fit of systems to **environment**" (1960, p.380), through selective retention of blind **variation**.

There could be more to it, since a continuous **evolution** of the **environment** takes place precisely through the permanent **changes** brought about by the various adapting systems within it.

N. BOTNARIUC pointed out that : "Adaptation is a **population** or species **level process** (i.e. supraindividual **level**) and it is different in nature from adequacy; it is the result of the historical action of natural **selection**" (1966, p.97).

0027

ADAPTATION and ADAPTABILITY^{1) - 3)}

1. Adaptation is a supposedly **stationary state** which implies a minimal **strain** between the system and its **environment**.

2. Adaptability is a permanent **process**, by which the system produces new adapted **states** whenever necessary.

W. KARGL explains it in the following way: "As **ontogenesis** must be understood as **drift** of structural **change** in **organisms** and in **environment**, there are no better or worse adaptation, but numerous possibilities for the **organisms'** relations with their **environment**" (1991, p.577).

Adaptation and adaptability are thus quite antinomic. A perfectly adapted system depends on the perfect **stability** of the **environment** to which it has adapted. If this adaptation is so absolute that it cannot be modified anymore, the system is in great danger of being destroyed, should its **environment** start to change. On the contrary, if it has maintained a potential for new adaptations (i.e. adaptability), it is generally able to respond successfully to new **changes** in its **environment**.

Adaptability "consumes" **redundancy** in order to produce successive adaptive **states**.

→ "**Order from noise principle**"

0028

ADAPTATION by step functions²⁾

L.von BERTALANFFY writes: "ASHBY's **model** for **adaptiveness** is, roughly that of **step functions** defining a system, that is, **functions** which, after a certain **critical value** is overstepped, jump into a new family of differential equations. This means that, having passed a **critical point** on its **trajectory**, the system starts off in a new way of **behavior**. Thus, by means of **step functions**, the system shows adaptive **behavior** by what the biologist would call **trial and error**: it tries different ways and **means**, and eventually settles down in a **field** where it does not come anymore in **conflict** with **critical values** of the **environment**" (1956, p.7).

ASHBY's **homeostat** is an electromagnetic **model** of this adaptation **mode**.

The adaptive capacity of any system thus depends on the existence, at least potentially, of this type of **step functions**. This **model** can be usefully compared with other concepts related to adaptation: **Requisite variety**, **Hypercycle**, **Organizational closure**, **Catastrophes**, **Bifurcation**, **Stability** in **topological** terms, etc...

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0029

ADAPTATION by ULTRASTABILITY¹⁾

A **complex system** will adapt to a given **environment** "by providing **second order feedbacks** that veto all **states of equilibrium**, except those that leave each essential **variable** within its proper **limits**".

Furthermore: "The **organism's** reacting **part** is itself divided into **subsystems** between which there is no direct **connection**. Each **subsystem** is assumed to have its own essential **variables** and **second order feedback**". (ASHBY, 1960, pp.208-209)

This concept is obviously akin to:

- 1.- Vendryes' **autonomy** by internal **regulations**
- 2.- Maturana and Varela's **organizational closure**
- 3.- Eigen and Schuster's **hypercycle**

An important remark by ASHBY is that "The **environment** is assumed to be **polystable**" (Ibid). Of course, no adaptation would be possible in a totally incoherent **environment**.

0030

ADAPTATION (Cumulative)³⁾

W.R. ASHBY demonstrates that: "...for the **accumulation** of adaptations to be possible, the system must not be fully **joined**" (1960, p.155)

This is a very important statement. It explains the reason why adaptation is, in some way **antagonistic** to **adaptability**. The **living system** needs a high degree of basic adaptation, which is obtained by **organizational closure** (related to a specific kind of **environment** and genetically shaped), which in turn limits **adaptability**. A very restrictive **organizational closure** implies that the system is strongly **joined**, as for example in the case of immunological rejection.

It could be also inferred that a high degree of **artificial intelligence** could be attained only by loosely **joined systems** of many **elements** and **subsystems**, which seems also to be the way the **brain** is organized.

0031

ADAPTATION (Noogenetic)⁴⁾

An adaptive ability proper to **human systems** able to understand specific adaptive needs and plan corresponding adaptive **modes**.

This notion has been derived from K. BOULDING: differentiation between biogenetic and noogenetic evolutionary **forms** (i.e. whose **evolution** is strongly influenced by their **brain**).

Noogenetic adaptation produces an acceleration of the **rhythm** of adaptation, which also explains the **evolutive acceleration** of mankind, that does not depend anymore merely on biological **change**. (F. MEYER, 1954, 1974)

0032

ADAPTATION (Obstacles to)¹⁾²⁾

Some of the most significant obstacles to adaptation are:

- Difficulty to evaluate former **performance** due to:
 - a) incomplete **data**
 - b) poor **criteria** for defining positive or negative **performance**
 - c) difficulty to distinguish between different **causes** of poor or good **performance** (causal multidimensionality implying **nonlinearity**)
 - d) difficulty to distinguish between short, medium and long **trends in performance** (a poor **performance** can be a near **random short-term fluctuation** or a **symptom** of a deep seated problem)
- Difficulty to discover **elements** or conditions that may lead to a better **performance**, including difficulty to select the most useful ones
- Difficulty to distinguish and overcome negative factors that induce poor **performance**
- Difficulty to arbitrate **trade-offs** between desired but contradictory **performances** (speed versus capacity in a **network** of roads, for ex.)
- Difficulty to avoid future local **optima** that may become dead ends

0033

ADAPTATION (Pre-)

→ **Pre-adaptation**

0034

ADAPTATION (Reciprocal)¹⁾

The **process** through which two or more systems or **populations** adapt to each other.

The systems must be compatible and more or less **complementary** in order to allow for a **process** of reciprocal adaptation.

For example, some plants, when attacked by a parasite, produce terpenes, which in turn attract parasites of the parasite. As a result, a global fluctuating **equilibrium** (even if frequently **chaotic**) tends to become established.

This **process** has been called "rivalrous adaptability" by H.G. BURGER, who sees it as a requirement for **complexity** (1967, p.211)

The **stability** of reciprocal adaptation can be altered among interacting **populations** if one of the partners starts to evolve. In such a case, reciprocal adaptation can still be maintained if the other partners succeed in turn in producing workable evolutive ways to respond to the **change**. We then have **co-evolution**.

0035

ADAPTATION (Second level)¹⁾

In case of necessity a **long-term** adaptation may replace a **short-term** one. G. BATESON gives the example of high altitude acclimatiza-

tion, as a human being will after some time, replace panting and heart acceleration by complex physiological **changes**. This 2nd level adaptation is more permanent than the 1st level superficial **changes**.

BATESON calls this type of adaptation "defence in depth" (1973, p.321).

This kind of adaptation is somehow **hierarchical**, as thus explained by W.T. POWERS: "... lower-order **reference levels** become the **means** by which higher-order systems act; the higher systems freely adjust the lower-order **reference-levels**, to create the lower-order **elements** of **perception** which will result in the specified higher-order **perception**. This creates a **hierarchy** of adaptation" (1976, p.84)

Ethological examples are also known and it would be interesting to try to find cultural ones.

0036

ADAPTATION (Serial)¹⁾

An adaptive **process** that follows a sequential **order**.

ASHBY, who introduced the notion, comments: "A great deal of **learning** occurs in this way. Mathematics, for instance, though too vast and intricate for one all-comprehending flash, can be mastered by stages. The stages have a natural articulation which must be respected if mastery is to be achieved" (1960, p.200).

ASHBY shows through other examples that serial adaptation is quite a general **pattern of behavior**.

0037

ADAPTATION PLAN (Genetic)²⁾

A naturally existing, or artificially installed plan for adaptation in a system..

The adaptive plan must respond to the following fundamental questions, as stated by J. HOLLAND:

"To what **parts** of the **environment** is the **organism** (system, **organization**) adapting?

How does the **environment** act upon the adapting **organism** ?

What **structures** are undergoing adaptation ?

What are the **mechanisms** of adaptation ?

What part of the history of its **interaction** with the **environment** does the **organism** **retain** ?

What **limits** are there to the **adaptive process** ?

How are the different hypotheses about **adaptive processes** to be compared ?

Moreover, as we attempt to answer these questions in different contexts, essentially the same obstacles to adaptation appear again and again. They appear with different names and

guises, but they have the same basic **structure**. For example, "**nonlinearity**", "false peak", and "**epistasis effect**" all designate versions of the same difficulty" (1992, p.2)

"False peak" is equivalent to "**local optimum**".

A general genetic adaptive plan may produce a number of different plans more precisely adapted to more specific conditions.

0038

ADAPTEDNESS^{1) - 3)}

Good **adaptation**.

H. PATTEE discussed this ambiguous concept in the following way: "How do we go about determining adaptedness? If a species is well-adapted, does this mean that **selection** pressures are low and we should not expect rapid evolutionary **change**? Or is evolutionary **creativity** an important component of **adaptation**?" (1972, p.33)

In other words, which one is better adapted: the amoeba, which has survived changeless for hundreds of millions of years by cloning itself, or man, a rather more recent, complex and "efficient" being, but whose future **survival** is anybody's guess?

In PATTEE's opinion, different criteria of adaptedness should be used at different **levels of complexity**.

0039

ADAPTIVE BEHAVIOR¹⁾

1. Any behavior that safeguards or enhances the **survival** ability of a **living system**.

2. "A form of behavior which maintains the essential **variables** within physiological **limits**". (W.R. ASHBY, 1960, p.58)

ASHBY starts with a sharp critique of the behavioristic concept of adaptive behavior: "The suggestion that an animal's behaviour is "adaptive" if the animal "responds correctly to a **stimulus**" may be rejected at once. First, it presupposes an **action** by an experimenter and therefore cannot be applied when the free-living **organism** and its **environment** affect each other reciprocally. Secondly, the definition provides no **meaning** for "correctly" unless it means "conforming to what the experimenter thinks the animal ought to do. Such a definition is useless".

Thereafter, he introduces the quoted definitions.

ASHBY's concept derives directly from Walter CANNON's **homeostasis** and indirectly from Claude BERNARD's "constancy of the inner **medium**".

Further along, ASHBY states "Adaptive behavior is equivalent to the behavior of a **stable** system (i.e. a system endowed with **dynamic stability**), the **region of stability** being the **region** of the **phase-space** in which all the es-

sential **variables** lie within their normal **limits**". (p.64). ASHBY proceeds by citing authors as diverse as STARLING, CANNON, PAVLOV and McDUGALL, who expressed much the same idea.

The individual adaptive behavior should be distinguished from the collective **adaptability** of a species, which is quite wider and in some cases at the expense of many individuals.

The concept should be extended to psychological and sociological behavior, even if these are very difficult to define in terms of measurable **variables**.

In more evolved **living systems**, adaptive behavior is obtained through **learning** or training. However, as stated by ASHBY: "The direct intervention of **consciousness** is evidently not necessary for adaptive **learning**" (1960, p.11)

One could argue that this is true only for **training**, if one considers training as non-conscious **learning**.

0040

ADAPTIVE CHANGE¹⁾

According to G. BATESON: "Whatever the system, adaptive change depends upon **feedback loops**, be it provided by natural **selection** or those of individual **reinforcement**. In all cases, then, there must be a **trial and error process** and a **mechanism of comparison**. But **trial and error** must always involve **error**, and **error** is always biologically and/or psychically expensive. It follows therefore that adaptive change must always be **hierarchical**.

"There is needed not only that first-order **change** which suits the immediate **environmental** (or psychological) demand, but also **second-order changes** which will reduce the amount of **trial and error** needed to achieve the first-order **change**" (1973, p.245)

One wonders how this could be translated to cultural adaptive **change**. (A good case for research would be the shaping of the European Union)

0041

ADAPTIVE PROCESS¹⁾

"The **process** whereby a (biological) system responds to its **environment** so as to adjust to the **constraints** of the **environment** and to take greater advantage of the environmental circumstances" (T.F.H. ALLEN & T.B. STARR, 1982, p.261)

Actually, the authors have defined "adaptation". in this way. However, "adaptation" would better describe some **state** at some instant. The global result of an adaptive **process** is a **sequence** of adaptive **states**, while the adaptive **process** mirrors the adaptive capacity of the system, i.e. its **adaptability**.

ALLEN & STARR coined their definition in relation to biological systems, but systems made of many **living systems**, especially human ones, are also adaptive.

0042

ADAPTIVE PROCESS (Statistical)²⁾

"A **process** in which the **chance** occurrence of appropriate or inappropriate **behavior** is positively or negatively **reinforced**, respectively" (A. H. KLOPF, 1972, p.59).

According to KLOPF: "Such a **mechanism** eventually produces a **network** that, to some degree, models the **organism** and the **environment**. As the **model** becomes increasingly refined, the statistical aspect of the adaptive **process** becomes less apparent and **behavior** appears more directed" (Ibid.).

Using KLOPF's terminology, as well as ASHBY's, one may say that the **heterostat** tends towards the **homeostat** when its **behavior** tends to **stability**. On the other hand, they stabilize because any system must become **autopoietic**: its **coherence** can be maintained only if, in some defined **environment**, some types of **behavior** are either impossible, prohibited, strongly **constrained** or, on the contrary highly favored.

The system goes on, constructing progressively its own **algorithm**, by a **trial and error process**. Besides, it constructs this **algorithm** in a specific way, because it does not start from scratch, but from some **archetype**, which allows only for a pre-defined **repertory** of admissible **variations**.

0043

ADAPTIVE SHIFT¹⁾

A **process** in a **population** through which individuals resistant to some destructive factor become gradually more numerous, while non-resistant individuals are eliminated.

This **process** had been observed already in the 19th century, for instance in a moth living on the bark of birches in England, adapting to the blackening of the colour of the bark due to industrial pollution and as a result of selection pressure exerted by predator birds.

The danger to produce similar **side-effects** by the use of insecticides or antibiotics, was signaled as early as 1953, but not heeded. Adaptive shifts have now produced the appearance of resistant **populations** of many insects and pathogens. The lesson has however not yet been learned, as shown for example by the dubious use of genetic engineering to create selective resistance to chemical killers in cultivated plants with the hope to selectively kill weeds, which supposedly could not acquire such resistance.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0044

ADAPTIVE SYSTEMS (Basic characters of)¹⁾

To begin with, as observed by L.A. ZADEH, "... all systems are adaptive, and the real question is what they are adaptive to and to what extent" (in G. KLIR, 1991, p.143). Indeed, a non-adaptive system could not survive at all.

KLIR observes, furthermore, that even a **goal-oriented system** must maintain its **goals** within a **range** allowing for its own **survival**, "which implies that the (very) **goal-seeking element** must be capable of **adaptation**" (1991, p.149)

It is also difficult to conceive an adaptive system that should not be endowed with at least a modicum of **anticipatory behavior**.

A. WILDEN establishes the following list of characteristics of adaptive systems, inspired by M.C. MARNEY and N.M. SMITH (1964):

1. Auto-differentiation or **growth**
2. Characteristic **response**: A **response** or a **set** of possible **responses** **constrained** by the limited **semiotic liberty** of the system. This **response** could be modified at the "**learning to learn level**" and also by **evolution**
3. **Selectivity**: The capacity of distinguishing **stimuli information** from **noise**, the **form** from the **background**.
4. **Learning**: Capacity of modifying the characteristic **responses**
5. **Homeostasis**: **Synchronic stability** within **limits**
6. **Homeorhesis**: **Diachronic stability**, of first **order** also within **limits**.
7. **Redundancy**: Protection of the system against **random perturbations** (implied in 5 and 6).
8. **Memory**: The sine qua non of **communication**, depending of the clues.
9. **Simulation**: Some form of **behavior**, mediated by **memory**, application, reduction, **semiotics**, **language**, including the capacity of **reproduction**.

"This enumeration is not supposed to be absolutely complete, nor to establish ordered priorities among the mentioned characteristics" (WILDEN, 1972, p.61)

It may be objected that **homeostasis**, as well as **homeorhesis**, is **diachronic**, if one admits that the first word is synonym of **dynamic stability**. The difference between **homeostasis** and **homeorhesis** is that, while **homeorhesis** characterizes the **growth** period of the system, **homeostasis** is proper to its maturity (specially in biological systems), when the system only maintains, without wide modifications, its **structures** and **functions** within more or less narrow and invariable **limits**.

As to **redundancy**, it only protects the system if it can be used to enhance its **variety** or at least to reveal it.

0045

ADAPTIVENESS¹⁾

"The ability of an individual or system to modify itself or its **environment**, when either has changed to the individual's or system's disadvantage, so as to regain at least some of its lost **efficiency**" (R.L. ACKOFF & F.E. EMERY 1972, p.124).

ACKOFF & EMERY write: "The definition of adaptive implies four types of **adaptation**:

- Other-other **adaptation**: an individual's or system's reacting or responding to an external **change** by modifying the **environment**;
- Other-self **adaptation**: an individual's or system's reacting or responding to an external **change** by modifying itself;
- Self-other **adaptation**: an individual's or system's reacting or responding to an internal **change** by modifying its **environment**;
- Self-self **adaptation**: an individual's or system's reacting or responding to an internal **change** by modifying itself" (Ibid)

0046

ADAPTIVENESS (Limited)^{1) - 2)}

It stands out of ASHBY demonstration that "...for the accumulation of **adaptations** to be possible, the **system** must not be fully **joined** (1960, p.155)" that any further **adaptation** tends to increase the degree of "jointness" of the system, or in other words to increase **constraints**. As the system's **variety**, even if considerable, is limited, there seems to be a progressive increase of the defined possible **states** and a reduction of the potential for defining new ones, i.e. of adaptiveness.

In ASHBY's words: "**Adaptation** (we would say "adaptiveness")...demands not only the **integration** of related **activities**, but the **independence** of unrelated **activities**" (p.157)

0047

ADDING JUNCTION²⁾

The spot where two **energy flows** of similar type add up. (adapted from H. ODUM - 1971, p.39)

0048

ADDITION²⁾

"The **relation** of the joining of **parts** so as to increase their number" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.33)

Only the **composite systems** seem to offer this extremely simple way of reunion and **growth**. Examples are the accumulation of grains of sand forming a dune under the action of wind, or the gathering of locusts changing from solitary to gregarious phase, or a reunion of many non-related people to attend some sport **event**.

0049

ADENOSINE TRIPHOSPHATE (ATP)¹⁾⁵⁾

A rich energy-producing nucleotide (J. ECCLES, 1977, p. 233)

ATP's formula is $C_{10}H_{16}N_5O_{13}P_3$ and is an **energy** source in many **metabolic** reactions in living beings

ATP acts as a neuro-transmissor. Its action can be affected by Adenosine triphosphatase which is "an enzyme splitting of phosphate from ATP and so producing **energy**" (Ibid)

→ **Chemotaxis**; *Dictyostelium discoideum*

0050

ADJUNCTION²⁾

"Kind of **organization** whose governing **relation** is **symmetrical independence**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.36).

According to these authors, in this type of ordering: "**Parts** can survive their separation" (Ibid).

This corresponds to the case of **colonial systems**, or **colonies**. If, for some reason, the **links** between **elements** or **parts** become severed, each of them remains able to survive as an **autonomous** entity. Such is the case of the **elements** of a sponge, or the multiple clones in a **colony** of poplars, if the connecting roots are severed, or also in plants which propagate through rhizomes or stolons.

Starting from the adjunction mode of **organization** it is in principle possible to advance toward more **integration** or to return to **independence**.

0051

ADJUSTER²⁾

A system which is merely able to a limited degree to "hold its internal **variable** constant in spite of **changes** in the external **variable**".

G. BATESON, following C.L. PROSSER, proposes to distinguish **adjusters** and **regulators**, the latter ones being better able to maintain the **constancy** of their internal **medium** (Cf. Cl. BERNARD and P. VENDRYES).

BATESON gives the following examples: "... the homoiothermic animals are classified as **regulators** in regard to temperature while the poikiloothermic are **adjusters**. The same **dichotomy** can be applied to aquatic animals according to how they handle internal and external osmotic pressure" (1973, p.331)

BATESON added to these two categories the **extraregulators** (like man), which are able, up to a point, to control and modify their **environment**.

0052

ADJUSTMENT²⁾

"A systems-**environment interaction** or **process** by which the system responds to the changing requirements of its **environment**". (B BANATHY, 1973, p.85)

Adjustments, according to B. BANATHY "are **changes** that a system brings about in order to modify its **behavior, structure** and characteristics so that it can produce improved system **outputs** or **system states**" (Ibid.)

The capability for making adjustments is the general condition for **adaptability** in any system.

Speed is a crucial factor in adjustment. N RASHEVSKY states: "...whenever any system is displaced from its **equilibrium configuration**, it always takes a finite **time** to reach that **equilibrium** again" (1967, p.72).

If the need for new adjustments appears before the first one has been completed, complex **effects** related to the **time lag** mechanism may introduce new **phenomena**, as for example **hysteresis**.

0053

ADJUSTOR²⁾

Device for potential **regulation** in a system built in such a way as to be able to take account of certain possible **variations** of the **environment** and to produce appropriate compensatory **behavior** of the system.

A. LOTKA introduced the idea in 1924 and constructed an experimental **model** in the guise of an artificial mechanical insect fitted with a pair of antennae which act as a spatial **sensor** at some distance (1956, p.341,382).

Such an artificial device throws light on the nature of adjustors in natural systems:

- The adjustor is *specific*. It is able to interpret some **data** of a certain **class**, as for example evaluate the **critical** distance away from some obstacle.
- It must be able, at least potentially, to use the **data** transmitted by **effectors** and **elaborators**.
- It must be able to carry out the needed comparisons between the captured **data** and the registered **norms** ... (for example maxima length, or maximum tolerable potential or weight)
- In view that its **action** aims at avoiding potential inadmissible **situations**, it evokes in our minds the illusion of intentionality.
- Its registered **norms** imply a **range** of possible futures, which gives us the illusion of (perfect) **predictability**.

One may conceive the need for adjustors of adjustors, for **coordination** of complex **behaviors**. Such a notion is very stimulating for the study of neuro-physiological **behavior**, as well as social **regulations** or **artificial organisms** "physiology" or "ethology".

The "timer" concept, introduced by Jessie MILLER is an important development of the adjustor's concept. (1990)

0054

ADVANTAGE (EQUAL) PRINCIPLE

→ **Boundary of equal advantage; Density (Optimal)**

0055

AFFILIATION¹⁾⁴⁾

F. ROBB resumes as follows G. AHRNE's concept of affiliation (in his critique of this author's book in Syst. Practice and Action Res.12(3), p. 312):

"People are related (in **organizations**) by "affiliation", which is usually compulsory in the cases of kinship and citizenship and which is usually entered into by **choice** in other cases (i.e. in enterprises and voluntary **organizations**) "Affiliation allows access to certain material **resources** accumulated by the **organization** and it entails the **performance** of some more or less well-defined obligations.

Almost all goods...are owned and controlled by **organizations**. Hence, if people want to have access to anything more than the most simple goods, they have to join **organizations**, and promise to come back again.

"To become an "affiliate", you have to be admitted, perhaps by passing some test, and to be recognized by others in the organization as having a unique **identity**: but only an identity in relation to the **organization**. You have to exchange a loss of some **autonomy** for access to the **organization's** collective **resources** and power, you have to promise to submit to surveillance, recorded **control**, and coercion, and you must return to the **organization**. But all affiliates are substitutable, no one is indispensable to the viable **organization**"

While in this description affiliates are human, members of human **organizations**, it is obvious that affiliation is a feature in different forms of all **elements** of all types of systems, from **cells** in the living being to ants in the anthill. It is in fact a basic feature of **sociality**.

→ **Immunity**

0056

AFFORDANCE¹⁾

The kinds of **behavior** the **environment** allows to a **living system**.

This concept is introduced by J.J. GIBSON (1986, p.36-37). A typical example is as follows: "A **path** affords pedestrian locomotion from one place to another, between the terrain features that prevent locomotion... (as) obstacles, barriers, water margins, and brinks (the edges of cliffs)" (p.36).

Affordance defines thus the **tolerance limits** of **constraints**. According to GIBSON, the concept derives from K. LEWIN's *Aufforderungscharakter* (i.e. invitation character). Affordance is obviously related to the **competence** of the user of the **environment**, who has to *learn* which **behavior** is affordable in different circumstances.

0057

AFSCET¹⁾

Association Française de Science des Systèmes Cybernétiques, Cognitifs et Techniques

This french society organizes symposiums on a variety of scientific and social **issues** from a systemic or cybernetic viewpoint. Recent examples are: Integration du vivant au social (2003) and Evolution du vivant et du social (2002)

AFSCET also has specific interests groups, among them:

- Aspects systémiques du développement durable
- Intelligence artificielle et processus de décision
- Systémique et biologie
- Systémique et société

AFSCET publishes a journal: "Res-Systémica", which is sponsored by the Systems Science European Union. (<http://www.res-systemica.org>)

The web address of AFSCET is:
<http://www.afscet.asso.fr>

0058

AGEING¹⁾

Ageing could be understood as a **process** of **information** saturation in the system. As the system becomes more closely adapted, by the precise definition of evermore numerous internal **states** in **response** to external **noise** formerly assimilated, it seems to use up its **redundancy**. Thus, as it becomes better adapted, it also loses in a progressive way its potential for **adaptability** and its **thresholds** of **instability** become narrower, which implies a growing danger to cross one of them irreversibly and to destroy itself.

Ageing seems also related to **growth limits**. The system seems to become clogged with a growing number of **constrained interrelations** between **subsystems** and **elements**. It thus turns more rigid and less responsive to **disturbances** from its **environment**, until it reaches a **state of sclerosis**.

Altogether the system may become too voluminous, or overextended. In this case the **cost** of maintaining long and heavy **communication** lines becomes an additional burden.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Generally speaking, life is a **nonequilibrium process** submitted to the laws of **thermodynamics** and ageing is a disorganizing, or over-organizing **process** dominated by a growing difficulty to maintain a low internal **entropy**.

0059

AGENCY¹⁾³⁾

"The degree to which a person believes he or she can chose and act freely"(W. McWHINNEY, 1995, p. 5)

McWHINNEY writes: "People vary in the degrees to which they recognize **free will**, that is, on how much they can personally and collectively control **behavior** in their **environments**" (Ibid p. 4)

For a better appreciation of this notion, see "**Autonomy**" and more precisely P. VENDRYES's (1908-1989) views.(1956 and 1981)

0060

AGENT¹⁾

An active **element** in a multi-**elements system** or **network**.

J. ERCEAU and J. FERBER describe the following types of agents, at different **hierarchical levels** in the active multi-agents **system**:

- "**reactive agents**: these are at the lower **levels**. They merely dispose of a reduced **protocole** and **communication language** and ... their abilities rely only on a **stimulus/action rule**. The reactive agents **class** include various **levels**, according to their **group-forming** ability and capacity to produce global **behavior**;
- "**communicating agents**, which possess a complete **communication protocole**, but whose conversational and behavioral **parts** are **interdependent**;
- "**rational agents**, which possess precise abilities, beliefs and a partial **representation** of their **environment**, specially of the other agents within the system;
- "**intentional agents**, at the highest **level**, possessing explicit **goals**, specific plans which allow them to fulfill their **goals**, as well as the possibility to commit themselves to specific tasks, that they are obliged to carry out, or to contract other agents to execute certain **actions**". (1991, p.757-8)

This could be a stimulating **description** for a **model** of any society.

More recently, J. FERBER (1999) has given a much more precise definition of an agent: Agent is a virtual or physical entity which:

- 1) is capable of acting in an **environment**
- 2) can communicate directly with other agents
- 3) is driven by a set of tendencies (in the form of individual **objectives** or of a satisfaction/survival **function** which it tries to optimize)
- 4) possesses **resources** of its own
- 5) is capable to perceive its **environment** (but up to a limited extent)

6) has only a partial representation of this **environment** (and perhaps none at all)

7) possesses skills and can offer services

8) may be able to reproduce itself

9) whose **behavior** tends towards satisfying its **objectives**, taking account of the **resources** and skills available to it and depending on its **perception**, its **representation** and the **communication** it receives

"Having the properties 1-9) an agent can be considered as an "intelligent system"(Ibid)

From this description N. SAFFARPOUR (2000, p. 75) deduces the following characteristics of agents

- Agents are **autonomous**, i.e. have **control** over their own actions
- Agents contain some level of intelligence, from fixed **rule** to **learning engine** that allows them to adapt to **change** in the **environment**
- Agents don't only act reactively, but sometimes also proactively and don't simply act in **response** to **environment**, in other words agents are **goal oriented**
- Agents have social ability, that is they communicate with the user, the system and other agents as required
- Agents may also cooperate with other agents to carry out more complex tasks that those they themselves can handle
- Agents may move from one system to another to access remote recourse or even to meet other agents
- Agents are adaptive, that is change their **behavior** based on previous experience

All these specifications are quite significant in a general sense, even if some terms used may seem ambiguous (as f. ex. "intelligence", "move from one system to another")

→ **Adaptability; Artificial life; Autonomy; Behavior (Anticipatory); Intelligence (Distributed artificial); Stigmergy; Swarm**

0061

AGENT (Meta-)¹⁾⁴⁾

"An agent who is capable of some sort of **meta-level** reasoning about the multi-agent **community**". (M. PECHOUCEK et al., 2000, p. 659)

The authors state that the meta-agent neither controls the **community** nor serves as a **communication centre**". It is thus neither a **controller**, nor a "**black board**"

The authors distinguish two types of meta-agent's **activity**:

- static **observation**
- dynamic **observation**"

Through static **observation** the meta-agent obtains a "state of affairs" picture

By dynamic **observation**, it may predict for ex. an "approaching critical **overload** of an agent"(note: or possibly of the whole system)

On the other hand "from the point of view of the meta-agents impact on the **community** we distinguish two principal **roles**:

"- **Passive role**: the meta-agent does not influence the **community life-cycle**...it (merely) provides the user with the **information** on how the **community** evolves in **time**...The meta-agent playing a passive role does not have any means how to modify directly the multi-agent community.

"- **Active role**: the meta-agent affects directly some other-agents within the **community**. Here the meta-agent usually revises (by directly delivered **messages**) the local **knowledge** bases of the agents. The proper active role should be ensured by means of dynamic **observation**" (p. 659-60)

→ **Multi-agents system**

0062

AGGLUTINATION²⁾

Mode of **organization** governed by "**aseriality**, where **parts** have **intransitivity**, **connexity** and **symmetry**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.36)

This is the kind of **organization** proper to **composite systems**, whose **elements** gather or separate from each other without any **order**, are in direct contact and whose relative positions may vary in an indifferent way. Such are the case for example of flights of gregarious locusts, or human crowds.

The existence of such systems is simply a result of the global statistical **behavior** of the **elements**. Individual movements are however closely conditioned by some general characteristics of the **environment** as for example the prevailing winds, the **circadian rhythms** or some ideological polarization.

0063

AGGREGATE²⁾

"A compound thing , the **components** of which are not coupled, linked, connected, or bounded" (M. BUNGE, 1979, p.4).

BUNGE gives as examples a celestial constellation, or a **random** sample of a biological **population**.

The only significative character of aggregates is a certain localization in **space** and permanence in **time**.

C. ZELLER constructed some **models** in order to establish the conditions of **stability** of aggregates (1967, p.53-55). This author states, for instance, that, in the case of geometric **elements** in a plane, **stability** "... is reached when six neighbours are gathered around a base **element**". (See: "**Hexagonal space filling**")

It depends, besides, on the shape of the **elements**, on the **initial conditions** and, probably on the nature of the substrate.

The **relations** among **elements** are thus not *absolutely random*. The aggregate, when submitted to certain variations of its **environment** may offer a degree of collective **behavior** which may even become repetitious and correspond to characterized **processes**, as for example **directional growth**.

The theory of **criticality** studies the **behavior** of such typical aggregates as snow or sand banks or the characteristics of aggregative **phenomena** as bush and forest fires, mud slides or stock market panics.

According to A. ANGYAL "Wholes cannot be compared to additive aggregations at all...

"In aggregates is is significant that the **parts** are added; in a system it is significant that the **parts** are arranged" (1969, p.26).

And, besides: "... aggregation and **whole** formation are **processes** of an entirely different **order**" (p.27)

It remains nevertheless true that aggregates seem in some cases to be the forerunner of **association** and **differentiation**.

According to V. KREMYANSKIY: "In **chaotic** aggregates, the **interconnections** between the **elements** are comparatively uniform, but they are particularly simple when a relative organizational simplicity typifies the **elements** themselves. The nature of the **elements** is not changed by entering or leaving the aggregate. Where there is a large number of **elements**, **changes** in the **chaotic whole** depend more on **changes** in many **elements** than on solitary or small **groups** of **elements**. The total of its internal **interconnections**, and hence the internal conditioning of the **changes**, bears a predominantly statistical or "probability" character". (1969, p.126-7)

Some authors use the term "**congeries**" (plural) as a substitute for aggregate.

0064

AGGREGATION 1 ¹⁾

A progressive **process** of **interconnections** between formerly unconnected **elements** or systems.

Aggregation is related to the existence of a **critical distance** between the **elements**. The **process** takes place when **crowding** becomes such as to hinder the fully independent **relation** of each **element** with its proper **environment**.

A famous example of aggregation – in **living systems** – is the life **cycle** of the slime mold *Dictyostelium discoideum*. The growing proximity of the individual amoebas (due to a combination of **population** explosive **growth** and the exhaustion of food) induces reciprocal **perception** of biochemical products and gregarious reactions leading to social **behavior**, in accordance with H. PATTEE's **statistical closure**. Aggregation thus seems to be a **process** basic for the shaping of social **living systems**.

One wonders if the massive intercommunication **process** presently in progress between human **groups** does not herald global mankind aggregation in the same way.

0065

AGGREGATION 2 ²⁾

The compression of a **set of data** into less numerous units which presents their common properties.

The most radical aggregation mode is statistics, a powerful **variety reductor**.

H. SIMON notes that, in many **complex systems**, analysis is much simplified by the fact that the influences on each **element** of all other **elements** are organized in a simple way. This is because the anonymous character of the specific **interactions** leads to a very important simplification, not only of the global system, but also of the **functions** which describe the **component** systems (1990, p.138).

→ (SIMON's Hora and Tempus parable)

While such a simplification is very useful, it also may be altogether sometimes questionable, because it may imply (and generally does) a loss of **information**. Furthermore, it is the *observer* who decides the **level** of aggregation, in accordance with his/her specific interest (and personal **blindspots**). This **level** can be for instance micro- or macrophysical, chemical, biological or sociological.

Another difficulty has been signaled by K. KRIPPENDORFF: "Aggregation leads to misleading indicators and theories whenever the whole collection exhibits an **organization** not expressed in a mere **summation**" (1986, p.1)

In complex systems, aggregation of **data** may occult relevant **interrelations**... or even introduce imaginary ones, when the "common" properties result merely from a mere unconscious and unwarranted hypothesis. These distortions may occur, for example, in the construction of complex **computer models**, needed in **systems dynamics**.

This problem turns worse if the aggregated **variables** do not any more correspond to observable **state variables**, as for instance in the global aggregate called "pollution". J. MARTINO observes: "... the effect of pollution on **population** actually occurs as effects of specific pollutants on specific individuals" (1979, p.17).

0066

AGGREGATION (DIFFUSION LIMITED)(DLA) ²⁾

A **fractal** aggregation type of **model** constructed on a computer, that starts with a single seed particle and grows to form a **cluster** by allowing tiny circular particles to attach themselves, one at a time (After I. STEWART, 1992, p.14).

STEWART explains: "Successive new particles move towards the **cluster** in a "random walk", a series of **random** motions in all directions often likened to the motion of a drunkard. Wherever the particles hit, they stuck" (Ibid).

Clusters thus obtained "... offer a "random fractal geometry"... difficult to characterise in analytic terms; that is no one has a way of predicting the **pattern** that will be generated, short of doing an experiment and observe the result... (However)... surprising regularities emerge from apparently unstructured DLA **clusters**" (Ibid).

Furthermore, the observed **fractal patterns** bear a great similarity with a number of natural **forms** as in electrodeposition of metals and in the **growth** of bacterial **colonies**. Some kind of **order**, related to **fractalization**, seems thus to emerge from **randomness**, and seems to govern the progressive occupation of **space** under partially undetermined conditions.

0067

AGIL imperatives ¹⁾

A mnemonic for remembering "the four imperatives that must be adequately fulfilled for a system by its **subsystems** if that system is to continue to exist" (M.C. JACKSON, 1992, p.46).

"The **meaning** of the terms that make up AGIL is as follows:

A. **Adaptation** – the system has to establish **relationships** between itself and its external **environment**

G. **Goal attainment** - **goals** have to be defined and **resources** mobilized and managed in pursuit of these **goals**

I. **Integration** – the system has to have a **means** of coordinating its efforts

L. **Latency** (or **pattern maintenance**) – the first three requisites for organizational **survival** have to be solved with the minimum of **strain** and **tension** by ensuring that organizational "actors" are motivated to act in the appropriate manner" (Ibid)

As mentioned by JACKSON, these four imperatives were originally stated by T. PARSONS and N.J. SMELSER.

0068

AGONOMETRY ^{1) - 2)}

"**Adaptability** through rivalry" (H.G. BURGER, 1967, p.209-22)

According to BURGER: "... all types of **evolution** are different in **structure** but similar in **process**. They consist of a rivalrous **polymorphism** that awaits **environmental change**. Up through the ethological **level** the **change** is **exogenous**, such as climatic. At the ethnic and intercultural **levels**, an additional type of **change** becomes available through **perception**" (p.209).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Polymorphism is equivalent to **variety**. As to rivalry, it should not necessarily bring about the elimination of the (presently) ill-fitted. They can remain in a minority position as a **variety store** until circumstances change.

BURGER applied his **concept** from biology to sociology and even **linguistics (polysemy)**. It never became widely recognized, possibly because of its "struggle for life" undertones, arguably more apparent than real.

0069

AGONISTICS³⁾

A general **model** of dialectical **antagonisms** in biological and **social systems**.

This concept has been proposed by the French physician E. BERNARD-WEIL (1975). It is related to **stresses** in systems due to **dissymetries** and maladjustments. The author uses the bow and the string as a **metaphor**. He studies numerous examples of such **antagonisms** and proposes a mathematical formalism. He acknowledges the old sources of the **concept**, as can be found in ANAXIMANDER, HERACLITES and the Chinese **concept** of YING and YANG.

The connexion with **symmetry-breaking** is also obvious.

0070

ALATORY (or random) PHENOMENON²⁾⁻³⁾

According to M. BELIS: "Aleatory phenomena present a subjective aspect related to the **observer** and an objective one, which corresponds with their own nature. The subjective aspect consists of the difficulty to know (by **observation** or by **measure**) the perturbing phenomena which exert some influence on the results of the **process**. The objective aspect is precisely the fact that the **process** can be influenced by infinitesimal variations of the **environmental** phenomena, i.e. that it is **unstable**. While perturbing phenomena generally also take place in **deterministic processes**, the **stability** of these latter makes them invulnerable to **perturbations**. A phenomenon is either **random** or not, independently of the presence of an **external observer**, but according to the **instability** or **stability** of the causal **connection** which determines it. As POINCARÉ did notice, the movement of the heavenly bodies is a **stable, deterministic phenomenon**, independently of the degree of any terrestrial **observers** ignorance, while dice throwing is aleatory because of the **instability** of the **causal connexion** which determines the results" (1938, p.66).

However, POINCARÉ himself has been the first to show that, even objectively, the movements of the heavenly bodies are not rigorously **deterministic**. He demonstrated the impossibility to find a perfectly exact solution to the

three bodies problem and set the first bases of the theory of **chaos** which is presently being developed (Understanding **chaos** as **randomness** within **deterministic limits**).

M. BELIS pursues nonetheless as follows: "However, after a long succession of experiences a **stability** of the results appears in cases in which the **unstable causal connections** are a structural make-up of a number of permanent causes".

This is precisely how most aleatory phenomena, **random** at **short term**, show nevertheless at long **term** an embedding global **determinism**, which figures basically a kind of statistical **limit to randomness**.

0071

ALERT CONTROL→ **Control (Alert)**

0072

ALGEDONIC LOOP²⁾

A positive or negative reward **feedback**.

Algedonic means: by pain or pleasure, i.e. implying punishment or reward.

Rewards can be quite various in kind. St. BEER cites as examples: teaching, bribing, the **epigenetic landscape** (1968, p.368). The **concept** appeared in psychology with PAVLOV and was (over) exploited by B. SKINNER.

According to BEER the algedonic loop "... interferes with the alleged **randomness** with which the **variety generator** pose solutions, as well as vetoing further attempts to pose the same unsatisfactory solution as before. It biases the throw of the dice" (p.368)

Further along BEER explains how this reward **feedback** allows very **complex systems** to produce in due time – notwithstanding the necessity of considering many interconnected conditions for **action** – "... a very ingenious and appropriate **response**" (p.395)... and how, if corrective **mechanisms** "were highly stable, their **response** to gross **perturbation** would be too sluggish and would call for huge **control energies**" (p.396).

The algedonic loop could probably be usefully mimicked in **Artificial Intelligence**

0073

ALGORITHM^{2) - 3)}

A step-by-step ordered and finite **set** of prescribed **operations** along an optimal **path**, whose use permits the solution of a specific **class** of problems.

Any algorithm implies **determinism**.

J.Z. YOUNG gives a definition related to computation: "A **program** by which a complicated calculation is reduced to a long series of simple ones" (adding: "that a digital computer can perform": see hereafter the comment on artificial – or natural - **neural networks**).(1978, p.289)

G. KLIR states: "The intuitive notion of an algorithm was formalized in several ways, including formalizations based on the concepts of **TURING machines**, **MARKOV** algorithms, and **recursive functions**, which were all proved to be equivalent" (1991, p.127)

An algorithm may be quite complex and contain a number of subordinated **routines** and instructions for their eventual use. However, the **TURING machine** is, at least in principle, a universal **representation** of all possible algorithms. The potential and global use of an algorithm is strictly limited to its **content**, which necessarily reflects an implicit and specific **representation** of its **field** of application.

GÖDEL's **incompleteness** concept is thus valid for any algorithm.

As to algorithms relations to natural or **artificial intelligence**, it can be argued that they are merely acquired properties of **brains** or computers. In the latter's case, they must be introduced in the **machine** as a product of natural intelligence. It is now however conceivable that artificial **neural networks** could become able to **construct** complex algorithms by **learning**.

According to R.W. FULLER and P. PUTNAM, this is precisely what the nervous system does: "... (the) basic operation of the nervous system: establishing a relative **dominance** among the members of a **class** of competitive motor **acts**" (1967, p.103)

Knowledge itself seems to be stabilized through algorithms. R. FISCHER, quoting H.M. COLLINS, writes: "... the discovery is generally re-constructed as if it followed an algorithm, a narrative receipt, with the experience of **contingency, trial and error** written off as irrelevant "**side effects**" (1992, p.229).

According to the Russian psychologist L. VYGOTSKY, children use private speech (i.e. speak to themselves) as a self-narrative way to acquire new skills, until the moment they dominate it. (L. BERK – 1994, p.60)

This possibly explains why **knowledge acquisition** through teaching is so different from discovery and self-training, and sometimes quite stultifying.

0074

ALGORITHM (Back propagation)⁵⁾

A procedure to compute the **errors** resulting of the **activity** (EA) **level** of a unit in a **neuronal** computer **net** (i.e. the difference between the actual and the desired **output**), and to correct accordingly the corresponding **error weights** (EW).

In a neuron which processes **signals** (= **activities**) each **input** is multiplied by a number called the weight. The sum of the weights, as computed by the neuron, determines the **output** of the neuron through an **input-output function**.

If the **output** differs from the desired **activity**, i.e. when there is an **error** in **activity** (EA), this **error** is calculated as "the square of the difference between the actual and the desired **activities**", as stated by G. HINTON.

The weights are then modified in order to reduce the **error** in **activity**.

The back-propagation algorithm – invented around 1974 by P. WERBOS – is thus basically a **feedback process**.

In HINTON's words, "The back-propagation algorithm is easiest to understand if all the units in the **network** are **linear**... For **nonlinear** units, the back-propagation algorithm includes an extra step. Before back-propagating, the EA must be converted into the EI, the **rate** at which the **error** changes as the total **input** received by a unit is changed". (1992, p.106)

This corrective mechanism is iterative (see below)

0075

ALGORITHM (Framing)²⁾

The concept of framing algorithm surges from the successive applications of internal **rules** (for instance of **positional values**) to incoming **inputs**. Progressive betterment of their **assimilation processes** tend to stabilize into more closely defined **channels**.

M. MARUYAMA proposed to apply this **model** to embryology: "Since **information** is generated by the **interaction** between various **parts** of the embryo, it is not necessary for each **part** of the embryo to contain **information** regarding the body **part** it is destined to become. It partly receives the **information** from other **parts** ... and from its **relationships** to them" (1963, p.238).

This looks like a case of progressive **organizational closure**.

0076

ALGORITHM (Genetic)²⁾

"A **stochastic**, **iterative**, evolutionary general purpose search **strategy** based on the principles of **population** genetics and natural **selection**".

The genetic algorithm was proposed by J.W. HOLLAND (1975, 1992) as a way to the **simulation** of adaptive **population** systems. He generalized it as "genetic **operators**" **models** that can be used for the study of **optimization** problems and more recently for **automata learning**.

The genetic algorithm, not being narrowly **deterministic**, does not lead to just a simple **solution**, but on the contrary opens the way for a progressive and adaptive search for better solutions in evolving conditions.

HOLLAND distinguishes the following transforming operations: crossing-over, inversion, **mutation**, **selection**.

These **operations** are found in nature. But they are frequent in any system wherein numerous **agents** act collectively as a **population** engaged in an adaptive search.

A. AGAPIE writes: "Genetic algorithms (GAS) are robust probabilistic algorithms for optimization, relying strongly on **parallel computation**. their power comes from multi-point exploiting of the searching **space**" (2000, p. 35)

→ **Neural networks; Parallel distributed processing**

0077

ALGORITHM (Iterative refinement)⁵⁾

An algorithm which progressively produce better answers when iterated.

As "the **backpropagation algorithm** is just a steepest descent approach without any line search... it inherits the well known disadvantages of the **gradient method**: The **convergence** depends strongly on the starting **values** of the **parameters**. The direction of the local steepest descent is often far different from the overall direction where the minimum lies" and... "The algorithm... normally either **overshoots** the minimum (with the risk of **oscillations**) or – if the **gradient** is small – there is hardly any progress at all" (TRONCALE, 1985, p.449).

This difficulty is alleviated by the introduction of iterative refinement algorithms.

Such algorithms are constructed from a **set** of **rules** whose **operation** is **interactive** and not rigorously **preprogrammed**.

It is however open to debate if such a kind of mental device really fits within the concept of algorithm.

0078

ALGORITHMIC COMPLEXITY²⁾⁵⁾

The degree of **variety** in a chain of **data**.

For example, the chain 001011101101001 is much more complex than 1010101010...., which can be reduced to a **program** "Repeat n times 10".

0079

ALGORITHMIC COMPRESSION^{2) - 3)}

"(Any) formulation which can explicate or reproduce an extensive **pattern** of **data** from only a few succinct **rules**" (D. Mc NEIL, 1993 b, p.3)

Mc NEIL sees science itself as a **process** of algorithmic compression: "The pursuit of science... results in **categorizations**, **classifications**, **taxonomies**, and formula which describe the **associations** and the **structures** attributed to **phenomena**. An ideal of a science is to design algorithmic compressions to describe its subject matter" (Ibid)

The paramount example is the search for the "theory of everything". **Systemics** and **cybernetics** also try to discover algorithmic compressions, in the guise of **transdisciplinary concepts** and **models**.

0080

ALGORITHMIC INCOMPRESSIBILITY^{3) - 5)}

The impossibility to reduce a string of **data** to a simpler algorithm that would permit to retrieve them.

G. CHAITIN demonstrated that: "A completely **random** string of digits cannot be reduced to a shorter **program** at all". On the contrary: "... a regular string of 1s and 0s describing some **data** such as 0101010101... which continues for 1000 digits can be encapsulated in a shorter instruction "repeat 01 500 times" (1990, p.45-46)

Chaitin related this finding to TURING's **un-computability theorem** and showed that: "the **halting** probability is arithmetically **random**" (Ibid)

According to CHAITIN, TURING's "... result that the **halting** probability is **random** corresponds to TURING's assertion that the **halting problem** is undecidable"

From another viewpoint, St. KAUFFMAN states: "One measure of the **complexity** of an algorithm is the minimal **program** length which yields the desired **output**. The more minimal an algorithm is, the less **redundancy** it contains. Consequently, minor modification of minimal **programs** grossly alter the **output** of the algorithm. In contrast, minor alterations of highly **redundant** algorithms modify **output** only slightly" (1993, p.231). Thus, algorithmic compression may make an algorithm's **behavior** more uncertain.

0081

ALGORITHMIZATION BY SELECTION¹⁾⁵⁾

The **process** of **reinforcement** of some neuronal groups in the **brain** and elimination of other groups.

This theory, proposed by G. EDELMAN (1987) as a "theory of neuronal groups selection", seeks to explain the progressive **organization** of the **brain** as a result of the acquired **dominance** of some groups of **neurons** which become frequently reactivated through re-entries of **signal** impulses.

This **process** leads to the **stabilization** of some specific perceptive and ordering **patterns**, which become the basis for future evaluations of new **perceptions**. It seems to correspond to the progressive construction of **reference frames**.

→ **Experimental frames; learning rule**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0082

ALGORITHMS (Genetic)²⁾

"A family of **methods** that search for optimal solutions of difficult **problems**" (P. DENNING, 1992, p.12)

The concept of genetic algorithm was originally developed by J. HOLLAND as a computer **modelization** of biological **evolution**.

P. DENNING writes: "Genetic search algorithms cross-breed trial solutions and allow only the **"fittest"** solutions (those accorded the highest **value**) to survive after several generations" (Ibid) They are thus, up to a point, self-perfectible, and a possible **model** for an evolutionary **mechanism**.

The genetic algorithm avoids at least partly what is possibly the most serious inconvenient of algorithms: their premature **stabilization** at a **sub-optimization level**. This result is obtained by a kind of "cooperative **competition**" by recombination or cross-over between different "candidate" solutions and the introduction during the progressive constructive **process** of a very slight **variability** ("mutations") within each elemental **situation**.

Kenneth DE JONG quoted by P. DENNING, states that "a mutation probability on the order of 0,001 per **bit** is enough to prevent the search from locking into a local **optimum**".

In this way, premature **sub-optimal** solutions are avoided and a global **optimum** can be more easily reached.

C. EMMECHE resumes as follows the **procedure** of a genetic algorithm:

"1. Select **program** pairs on the basis of how well they have solved the **task** (one can thereby measure **fitness**). The better the solution, the greater the **chance** to be selected.

"2. Apply the genetic **operator** (cross-over, eventually combined with a small **chance** of **mutation**) to the selected **program** pairs in order to create offsprings in the next generation.

"3. Replace the least successful **programs** with the offspring created in step two, and repeat the **process**" (1994, p.115)

He adds: "Empirical investigations indicate that this crossing-over scheme operates specially well on problems that programmers otherwise regard as genuinely difficult.

The genetic algorithms are able to exploit the **population** experience in an optimal manner" (p.116)

→ **Parallel distributed processing**

0083

ALGORITHMS' LIMITS³⁾

In relation to algorithms' possibilities to mimic intelligence, P. DENNING states: "For me, the existence of multiple, incomplete interpretations actually supports PENROSE's basic claims about mental as opposed to computational **processes**. Like a system of logic, an interpretation cannot include all **phenomena**. Our

powers of conscious **observation** give us a capacity to step outside a particular interpretation and devise extensions or alternatives. Thus **consciousness** itself cannot be captured by any fixed **description** or interpretation. How then can **consciousness** be captured by an algorithm, which is by its very nature a fixed interpretation? This question applies also to algorithms that are apparently designed to shift their interpretations, because the **rules** for shifting constitute an interpretation themselves" (1990, p.102).

Include a "theory of everything:" within an algorithm seems to be a hopeless task. However the **brain** itself becomes partly **constrained**, by **learning** specific skills and **behaviors**. Could this not be viewed as a partial algorithmization? As to the **rules**, should they not be left "open", as for example behavioral **rules** in a **network** in lieu of interpretation **rules** within an algorithm?

For an exhaustive debate on this topic see R. PENROSE's "The Emperor's new mind" (1989)

0084

ALGORITHMS THAT CANNOT BE CONSTRUED³⁾

N. KASKOV "demonstrated that the following mass problems could not be solved in the framework of the **General System Theory**:

- to construe an algorithm allowing to find all the **elements** of a given system
- to construe an algorithm allowing to find all the **connections** of a given system
- to construe an algorithm allowing to determine the **structure** of a given system
- to construe an algorithm allowing to determine all the **functions** realized by any given system (even if one knows its **elements**, **connections** and **structures**)" (BLAUBERG, SADOVSKY & YUDIN, 1977, p.205)

Any **complex system** seems to contain a power for innovative and unpredictable **variations**, due probably to its relatively open character.

0085

ALL OR NONE TRANSITION¹⁾

A type of **transition** that admits only two opposite **states**.

These **transitions** are congruent with the **all or nothing principle**. They admit no **fuzziness**. Examples are: open vs. closed; outside vs. inside; positive vs. negative; one vs. zero.

→ (**flip-flop device**)

0086

ALL OR NOTHING PRINCIPLE¹⁾

Stimulus-response situation in which **response** is unavoidably total, or nought.

J.C. TABARY notes: "Particularly at the sensorial neurons **level**, a univocal **response** appears when sufficient number of membranous **receivers** are simultaneously stimulated.

"The **organism** is informed about the **receivers stationary state**, but not on the peculiar characteristics of the stimulating **event** itself. Considering that, very generally, there are only two possible **states**: **information** is really restricted to one **bit** only". (1989, p.278)

0087

ALLEE EFFECTS

→ **Undercrowding**

0088

ALLELOPATHIC¹⁾⁴⁾

"Character of a substance which has inhibitory effects on other **organisms**" (P. COLINVAUX, 1973, p. 605)

In a more general and somewhat **metaphoric** meaning, it seems that some **informations**, **values** or **norms** exert inhibitory effects in societies.

→ **Inhibition**

0089

ALLOGENESIS²⁾⁵⁾

A **phase** of adaptive **radiation** in an **evolutionary process**. (W. SCHWEMMLER, 1991, p.152)

0090

ALLOMETRY²⁾

Fixed or variable proportional **relationship** between different **parts** in one or various systems

It is already an old idea to try to compare the modifications of the proportions of various **parts** of the same system through **time** or the proportions of a corresponding **part** of various systems at the same moment of their **growth**.

The 19th century French paleontologist Georges CUVIER used the concept as a "principle of **correlation** between **parts**": "Any organized being forms a **whole**, a unified and **closed system**, whose **parts** correspond all to each other and converge towards the same definitive **action**... None of these **parts** may change without **changes** in the others too, and as a result, each separately considered shows and gives all the others" (CUVIER, 1812, as quoted by Stephen J. GOULD - 1983)

This idea has been reworked and considerably extended, specially in relation to **evolution** by d'Arcy W. THOMPSON (1916 - re-ed.1952) and later on by J. HUXLEY, alone (1945) and in collaboration with E.C.R. REEVE (1972, and in HUXLEY, 1945, p.267)

0091

ALLOMETRY (Principle of)²⁾

"As the **growth** of any particular **structure** proceeds, in the absence of **change** in the **pattern** of the **structure** itself, volumes will grow eight times as fast and surfaces will grow four times as fast as **linear** dimensions" (K. BOULDING, 1972, p.87)

As observed by L.von BERTALANFFY: "The simple relationship of allometric increase applies to many **growth phenomena** in biology (**morphology**, **biochemistry**, **physiology**, **evolution**)" (1962, p.12)

Commenting on this principle, K. BOULDING expresses that it also applies to social **organizations**, in a more subtle way: "... **organizations** eventually limit their own **growth** simply by the sheer difficulty in getting **communication** from the "surface" of the **organization**, where it is in contact with its **environment**, into the **decisions**-makers who are not in direct contact with the **environment**" (1972, *Ibid*)

In this case, it is mainly a problem of **time lags**. However, even if **communication** is accelerated through technical devices, **strain** and **saturation** may well occur, by **overload**, or **chaos** may seep in.

0092

ALLONOMY²⁾

The property of a system characterized by **input-output relations** (LE PEUTREC, 1994, p.1553)

S. LE PEUTREC and M. COURANT explain: "Such a system needs an internal representation of its **environment**. The **environment** controls the internal functioning of the system" (*Ibid*)

This is the case of common **regulators**: While they endow some larger system with some **autonomy**, they themselves are not autonomous.

Allonomy is a property somehow complementary to **autopoiesis**. According to P. VENDRYES, **autonomy** is not possible without internal **regulators**, registering external **perturbations** and reacting to them as kind of **buffers** allowing for the permanence of the systems **identity** and **processes**.

Or: "Allonomy is a logics of correspondence, while **autonomy** is a logics of **coherence**". (*Ibid*, p. 1554). There is a kind of **symbiosis** between two **antagonistic behaviors**.

0093

ALLOPOIESIS^{1) - 2)}

The production by a **network** of interrelated **component-producing processes** of a system, which does not however becomes able to thereafter reproduce its **components** and **processes**. (Adapted after M. ZELNY and N. PIERRE, 1976, p.150)

According to these authors: "... the actual realization of such systems is determined by **processes** which do not enter into their (own) **organization**. They are non-**autonomous**, since their realization and longevity as unities are not related to their **operation**" (*Ibid*)

In another paper, ZELNY states: "Allopoietic systems are organizationally open. They produce something different from themselves" (1977, p.14)

Allopoiesis is of course the opposite of **autopoiesis**, which implies **organizational closure** and thus, **self-reproduction**.

ZELNY and PIERRE give as examples of allopoietic systems "crystals, formal **hierarchies** and concentration camps" (*Ibid*)

Complex **artifacts** as for example cars or planes or machine-tools seem still more allopoietic: they are not self-created and are controlled from outside.

However, if the allopoietic system is to be really a system, it must at the same time be **autopoietic** in order to maintain its **identity** and **coherence**. This would be possible if we admit that the **boundaries** or other **subsystems** transform **inputs** into internally fitting **elements**, i.e. integrates them into the **organizational closure cycle**, while producing **outputs** by an inverse **transformation**. Some of J.G. MILLER 20 critical **subsystems** do just that.

According to H. MATURANA, an **observer** may treat an autopoietic system as if it were allopoietic by considering the perturbing **agent** as an **input** and the modifications undergone by the **organism** (which maintain its **autopoiesis**) as the **output** (1974, p.425). This is, for example, the way of traditional psychiatry.

However, this treatment does not reveal the **autopoietic organization** of the system.

0094

ALLOSTASIS¹⁾

The conservation of dynamic **stability** during a **process of change** in a system

Any system or **subsystem** is normally able to cope with a more or less wide **range of inputs**.

As expressed by ASHBY, a system counts with a defined **variety** which allows it to adapt to specific variations in its **environment**.

The french biologist P. VENDRYES, in turn, explained that the system is able to maintain itself within **limits** of adaptive **fluctuations** if it counts with sufficient **reserves** (or **resources**) disposable for use.

Allostasis has thus a qualitative and a quantitative aspect.

However if variety and/or resources are insufficient and tend to be exhausted, non adequately compensated **input perturbations** create **stress** in the system.

If stress becomes excessive or persists for long **time**, the system may undergo severe damage and, in extreme cases, be destroyed.

→ **Break down; Collapse; Criticality; Equilibrium; General adaptation syndrome; Heterostasis; Homeostasis; Regulation; Synergetics**

0095

ALPHABET²⁾

"An ordered **set** of characters which can be combined to form the ensembles, words or expressions of a **language** or to represent **data**" (K. KRIPPENDORFF, 1986, p.2)

Many kinds of alphabets are in existence: the very numerous different alphabets of written and spoken **languages**, the conventional combinations based on a **binary code**, and even the 20 basic amino-acids of DNA and RNA chains.

To express that an alphabet is an "ordered **set**" means that it corresponds to differentiated **symbols** and that its use is **constrained** by defined **rules**. For example "chtch" is a sound and a letter in Russian and the combinations "mb", "ng", or "nz" are admitted in Kiswahili, but none of these are normally used in English.

Any alphabet is thus a specific system.

In a sense, any **taxonomy** that uses a kind of ordering base of **classification** to be applied on the combinations of a limited number of well defined **elements**, could be considered an alphabet.

0096

ALTER

→ **Contingency (Mutual)**

0097

ALTRUISTIC UTILITARIANISM

→ **Utilitarianism (Altruistic)**

0098

AMBIENT (= UMWELT)¹⁾

"The **set** of the small number of characteristics to which an **organism** reacts". (L.von BERTALANFFY, 1962, p.73)

This concept was introduced and developed by J.von UEXKÜLL and G. KRISZAT (1934, 1979)

BERTALANFFY explains the concept as follows: "...any **organism**, so to speak, cuts out from the multiplicity of surrounding **objects** a small number of characteristics to which it reacts and whose ensemble forms its ambient" (p. 73)

The **perceived** ambient is only a reduced **part** of the **environment**, which does not mean of course that non-perceived environmental conditions could not affect the **organism**. Exam-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

ples would be the effects on human beings of ultra-violet or X-rays, which were completely unknown to our forefathers and that we are still unable to perceive directly.

BERTALANFFY also notes that: "...the organizational and functional plan of a living being determines what can become '**stimulus**' and 'characteristic' to which the **organism** responds with a certain **reaction**" (Ibid).

von UEXKÜLL has given numerous and sometimes startling examples of ambients corresponding to various animals, showing how unexpected and even outlandish they can look for us.

This ambient concept, transferred to human **organizations**, may help to explain many failures of environmental **perception in management**.

0099

AMBIGUITY³⁾

The condition resulting from a **sign** or **signal** bearing different possible **meanings** for an **observer**.

Ambiguity results of the lack of a clearly selective **context** to allow for the clarification of **meaning**. It is a **perceptive situation**, related to **languages** (spoken, written, pictural or other). E. BUCHBERGER observes that: "Multiple **semantic meanings** cannot generally been solved in an isolated way and lead to considerable difficulties" (1987, p.57)

Any **receiver** possesses his/her **repertory** of interpretations of **signals**, but this **repertory** has been formerly learned.

If, for example, we look at the well known young woman, old woman picture, only one of both possible perceptive **gestalt** intervenes for us at any moment, exclusive of the other. The potential for ambiguity is in the picture, but it reveals itself only through the shifting glance of the **observer**.

According to A. RAPOPORT: "Even mathematical statements, which most people consider to be absolutely exact, and therefore either absolutely true or absolutely false, have a certain penumbra of ambiguity as they are usually stated. This ambiguity is less characteristic of mathematical statements than of others, but it is there nevertheless because certain qualifications are likely to be tacitly assumed in every statement. It would simply take too long to make a statement irreproachably unambiguous" (1967, p.292)

This problem is obviously related to the need to **recurrently** resort to **metalevels** for **distinction** or **validation** (**GÖDEL's incompleteness theorem**)

0100

AMPLIFICATION²⁾

"A **process** whereby a small **cause** has a large **effect**" (W.T. POWERS, 1995)

Amplification is "achieved by drawing on the **stores of energy** and bringing them to bear on the creation of narrowly focused **effects** in the **environment**..."

This possibility "...arises from the fact that **organisms** can draw on internal power supplies which are independent of the **energy** contained in **disturbances**" (Ibid.)

This is the same condition that leads to systems **autonomy** in the sense of P. VENDRYES (1908-1989)

0101

AMPLIFICATION AND STABILITY¹⁾

Amplification, if not compensated by for example a **negative feedback**, leads the **function** and the system towards an **instability threshold** and either a **runaway catastrophe**, or a **process of dissipative structuration**.

H. ODUM puts it this way: "In effect, a system is stable when the amplification factor of the **feedback loop** equals the potential **energy** losses along the **circuit**". (1971, p.181)

0102

AMPLIFIER²⁾

Any device suited to increase an **input signal**.

Amplifiers are generally incorporated within a **feedback device**. M.D. RUBIN even describes the **feedback** as "a unilateral power amplifier, with a fraction of the **output** of the amplifier subtracted from or added to the **input** of the amplifier" (1968, p.9)

H. ODUM describes a "constant **gain** amplifier", within an **energy network** in which: "...the amount of **energy** supplied from the upper **flow** is that necessary to increase the force expressed by the system by a constant factor, called the **gain**" (1983, p.39)

0103

AMPLITUDE²⁾

The maximum departure of an oscillating motion from its **time** -average **value** (T.F.H. ALLEN & T.B. STARR 1982, p.262)

0104

ANABOLISM¹⁾

The **process** of absorption and **assimilation** of specific **inputs** by a **living system**

The anabolic process includes the following phases:

- **Ingestion** or **transduction**: the translation of material, energetic or informative **inputs** from the **environment** into the system through its **boundary**.

- **Internal transfer**: the internal **translation** from the absorbed **inputs** to the **subsystems** that should use them.

- **Conversion**: the transformation of an **input** by a specific **subsystem** to make it fit for the use of the system. In the case of **information inputs**, the conversion **process** is called "**decoding**".

- **Production** or **association**: For material or energetic **inputs**, the synthesis of specific **components** of the system, out of the converted **inputs**. For **information**, the first stage of the **learning process**.

For the respective roles of the concerned **subsystems**, see J. MILLER's 20 **critical subsystems**.

The elimination of products by a **living system** is called "**catabolism**", while "**metabolism**" is the generic term for the complete **process** of absorption, **transformation** and elimination of **matter**, **energy** and **information**.

In a more or less analogic sense, higher **level living systems** (enterprises, **groups**, **organizations**, **communities**, etc...) all anabolize specific **inputs**.

0105

ANAGENESIS²⁾

"The step-wise **evolution** of the **dynamics** of **self-organization** itself, bringing into play new **levels** of systems with their appropriate **self-organization dynamics**" (E. JANTSCH, 1982, p.345).

JANTSCH, who introduced the **concept**, stated: "In microevolution, anagenesis arises from **endosymbiosis** of dynamic (or **ontogenic**) sequences of **structures**; in macroevolution from the **coevolution** of phylogenetic sequences of systems. It may be interpreted as self-transcendence in **space-time**" (Ibid).

This is the **evolution** of evolution **modes**. Anagenesis is probably to be connected with **emergence** of new **levels** of **complexity** through **dissipative structuration**.

This **process** also seems related to the appearance of higher **levels** of **sociality** (**cells** as societies of molecules, living beings as societies of **cells**, beehives as societies of bees, human societies) that produce *new types of individuals on a higher complexity level*.

The subject is very complex. JANTSCH's paper provides an interesting figure that makes it easier to understand.

0106

ANALOG PROCEDURE⁵⁾

According to J.von NEUMANN: "In an analog **machine** each number is represented by a suitable physical quantity, whose **value**, measured in some pre-assigned unit, is equal to the number in question" (1958, p.3).

The machine must be equipped with devices enabling it to operate suitable mathematical **transformations** on these quantities.

0107

ANALOGICAL or DIGITAL ²⁾ - 5)

Two different **methodologies** used in **simulation**.

Analogical **simulation** is based on **similarities** and uses mechanical, hydraulical or electrical **models** whose functional properties are sufficiently **similar** (i.e. **homomorphic**) to those of the **concrete system**. Reduced **models** of harbours, or scale **models** of **artifacts** are examples.

Digital **simulation** uses numerical analytical **models** that can be translated to **programs** adequate to be run on a digital computer.

0108

ANALOGUES ²⁾

"...systems which are physically different but dynamically equivalent" (R. ROSEN, 1972, p.56)

According to ROSEN: "... dynamical or functional properties can be studied essentially independently of specifics of physicochemical **structure**, while **fractionation**, or other **reductionist** techniques, are bound up with these specifics in an essential way" (Ibid)

0109

ANALOGY ³⁾

"A resemblance between the **relations** among things (rather than between the things themselves) (Adapted from J.W. SUTHERLAND, 1973, p.122)

K. KRIPPENDORFF states: "In the theory of **models**, an analogy between two systems is explained by one simpler system that **models** both, but by different **homomorphisms**" (1986, p.3) An analogy is thus a **limiting** conceptual **constraint**.

According to J.W. SUTHERLAND: "... the analogy is in the first and last instance a conceptual device designed to call attention to **isomorphisms**, and to engine the attempt to induce **causality** specific to a **phenomenon** by imposing a general **causality**" (p.123)

The first aspect does not seem objectionable. However, the second one could easily lead to dangerously sweeping generalizations by "embracing creeds" (POPPER, quoted by SUTHERLAND - p.117)

Further on, SUTHERLAND adds: "...analogies are properly used... as **masks** with which an a priori **chaotic situation** can be at least partially ordered, subsequent to empirical **validation** of the **causality** proposed by the **mask**. Grand operational principles then, in the hands of the serious scientist, simply become systemic, encompassing **heuristics** whose utility lies not in their reification but in their perspective". (p.127)

0110

ANALOGY (Abuse of) ³⁾

A number of serious abuses of analogy have been registered in the use of **cybernetic** and **systemic models**, generally by neophytes carried away by their initial enthusiasm for a **methodology** which seemed to them to promise grand solutions to intractable problems.

Obvious examples are the illusion of rigid **control** by **regulators** of mechanist types in biological, economic and social systems; some "**catastrophic**" (no pun!) **models of behavior** in **social systems** and, more recently some misunderstandings about **chaotic models**.

A subtler case can be found in J. FORRESTER's "**World Dynamics**" as it was applied in the famous first **Club of Rome** Report. This outstanding piece of work suffers from an excessive rigidity due to the presence of numerous cybernetic **loops** whose **simultaneity in action** is never considered (C. FRANÇOIS, 1977). In J.W. SUTHERLAND words: "... both human beings and the collectivities they form would have to be considered "dynamic, **goal seeking systems** that change their **environment** and are not merely passive victims of it" (F. GEORGE, 1970, p.21) and, if this is the case, then "the simple servoanalogy breaks down, as does our ability to collapse all relevant **behavioral** determinants into a simple, fabricative **state-variable**" (1973, p.124)

In any case K. BOULDING expressed: "If analogy is dangerous and leads to the development of untrue systems, the remedy is not to throw it overboard altogether, for there are **situations** in which no other **method** of systems development is open to use. The remedy for false analogy is not *no* analogy, but *true* analogy. This involves the development of a critique of analogy and a theory of **simulation**... It is ... one of the principal concerns of the **general systems** enterprise" (1974, p.36)

0111

ANALOGY-BUILDING ³⁾

As an attempt to transfer **similarities** from a **phenomenon** to another one, analogies imply some aspects that should be consciously assumed.

According to J.W. SUTHERLAND: "... analogy-building is an extension of assumptivism (note: see: **Assumptive Analysis, Reductionism**)... But the fundamental difference between assumptivism and analogy-building is that, in the latter case, we are imposing an entire **system of relations** rather than single **parametric values** or **sets** of predicates (cum first premises)" (1973, p.123)

St. BEER showed that the **process** of analogy building, or "scientific analogizing" consists in connecting conceptual **homomorphic models** of two or more **situations** (1968, p.111)

Using the example of the controversy around the **validity** of the analogy between **computers** and **brain** ("The **brain** is a **computer**" **metaphor**), A. RAPOPORT observes; "The controversy is obscured by clashing philosophical convictions.... The answer... is not to be found in what a **brain** and a **computer** "are" (such questions are vestiges of pre-scientific metaphysics), rather in what **brains** and **computers** do" (1966, p. 9)

We should add: and in which way they are doing it, as the **brain** seems to be working, at least partly, in a **simultaneous** manner, as a **network**, while the computer, at least the **digital** one, is basically sequential.

Ironically, analogy-building, in search of **homomorphisms** or **isomorphisms**, ends up in some cases as just a more refined **reductionism**. Systemists and cyberneticians should be aware of this !

0112

ANALYSIS ³⁾

"The separation of an intellectual or substantial **whole** into constituents for individual study" (The American Heritage Dictionary)

One of the most severe and persistent **semantic** muddle is the careless use of the term "analysis", even by systemists.

When a system is "analyzed", most or all of the **nonlinear interrelations** among its **parts** are unwittingly severed. As jokingly stated by J.L. LEMOIGNE, cutting a chicken into slices like a sausage does not yield an intelligible **representation** of the chicken. (1990)... and it should be quite more difficult to do.

Worse still, many people are not even aware of this problem. And different **observers** may "slice the chicken" in different ways, none very faithful to the original.

Analysis is perfect on its own (studying the **components** and at most their **linear relations**), but, as it generally leads to cutting the more complex **interrelations** between **interacting parts**, it is never a satisfactory substitute for the systemic global view, which is also indispensable for the study of **complex systems**.

Ideally, analysis should always be conjugated with **synthesis**, i.e. the synthetic view of the **whole**. Moreover this should also be a back and forth **movement**: analysis is useful and makes sense only in relation to the synthetic view and synthesis without a good **knowledge** of the interacting **parts** does not make much sense because it offers merely empty generalities that do not offer tools for action

0113

ANALYSIS (Functional) ²⁾

The functional analysis of a system includes:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- an identification as precise as possible of the distinct **functions** of the system and their **interactions** or interferences
- in this way potential disfunctions and **risks** can be identified and, as a result, possible risks can be discovered and assessed. This can be done by "hazards and operability studies"; "analysis of possible failures of **components**"; "**critical effects** study"; causes and consequences diagrams"; "**failures trees**"; and others.

Statistical analysis is one of the main tools in this kind of analysis, as well as **Petri nets** and **Markovian processes models**.

→ **Cindynics**

0114

ANALYSIS (Sensitivity)

→ **Sensitivity**

0115

ANALYSIS SITUS ²⁾

"The study of those properties of **space** which are independent of shape or **size**

Analysis situs or situational geometry is practically a synonym for **topology** and was first used in this sense by H. POINCARÉ. It is concerned with the properties of **forms, contiguity, connections...** conserved through continuous deformations, stretching or contraction, but exclusive of tearing or folding.

0116

ANAMORPHOSIS ¹⁾

Trend toward an increasing **complexity**

This concept, introduced by WOLTERECK (1940), "has been indicated as a primary characteristic of the living, as opposed to inanimate nature ... and was often used as a **vitalistic** argument" (L.von BERTALANFFY, 1969, p.79)

In BERTALANFFY's opinion organizational laws exist at all **levels** in the universe. To search for them is one of the basic goals of **General Systems research**.

In fact, it seems evermore well confirmed (see for example Carsten BRESCH, 1977) that this same tendency is – or was – already active at the micro-physical **level** and that it is linked to the very general **phenomenon** of **structuring dissipation** researched by **thermodynamics of irreversible systems**.

Note: Another (unrelated) meaning of this term is: "A mode of distortion of an **image** such as it can be viewed only from a special angle or with the help of some instrument".

These optical deformations were used by the Milanese painter ARCIMBOLDO (1527-1593)

0117

ANARCHY ¹⁾

On this concept, FLOOD states: "Anarchy itself suggests **disorder** and lack of government; however the argument is not one of **entropy**, but as follows. Anarchy can cause such **strains** on a system, including **positive feedback**, that the system itself may go through a **transition**. In many cases anarchic **behavior** is a **catalyst** of a system **transition**, not from a **state** to another (within a predetermined **state space**, one to one **mapping** of the **state variables**), but rather from one nature to another. That is, some essential qualities are replaced by another **set** of essential qualities" (1991, p.188)

FLOOD does not elaborate much as to the causes of anarchy. There seem to exist basically two:

- Weakening of the **control** of the system upon its **parts**;
- **Overload** of **inputs** from the **environment**, basically excess of **energy** or **information** inflow, which produces local or general unresponsiveness or confusion by **saturation** of **communication channels**.

FLOOD states that: "The system's **label** however, may well remain the same: France was still France after the revolution" (p.181). True enough about the "**label**". But what about the deep **identity** of the "France" system? This is a good example of how difficult it is to apply even systemic concepts to socio-cultural **situations**. **Metaphorically**, one could speak of destructive anarchy, as for example in cancer, and constructive anarchy as in the case of ebullient **elements** breaking down some established **structures** and producing, as a result, some more efficient or encompassing global **organization**.

Besides, anarchy as a concept whose systemic **meaning** is still ill defined, should be clearly distinguished from **chaos**.

0118

ANASTOMOTIC NET ^{2) - 5)}

A **model** of **neuronal net** "in which each neuron listens to many and speaks to many" (W. McCULLOCH, 1974, p.14)

This definition corresponds to a **model** created by S. WINOGRAD and J.D. COWAN in McCULLOCH's laboratory.

These authors used such **nets**: "... in such a way as to incorporate the **redundant error-correcting codes** used in **coding** for **noisy communication channels** into the logical **functions** computed by each neuron in the **net**. The probability logic which results from their construction is **functionally redundant**, there are many more possible **functions** stored in the **net** than in our own anastomotic **nets**, and it is this **redundancy** which is used to obtain reliable computation. Given the assumption that the **rate** at which neurons malfunction is not

tied to the number of **inputs** playing on each one, the WINOGRAD – COWAN construction is in a one-to-one correspondance with that of SHANNON's which led to the **noisy channel coding** theorem and the existence of a **channel capacity**. On this basis there is an **analogous** computational capacity for reliable computers made of unreliable **components**" (Ibid)

In view of the recent developments in **neuronal nets** applications to **robotics** and **connection machines**, and their possible use for the study of **sociality**, this was indeed, in the fifties, inspired work.

0119

ANASTROPHE ¹⁾

Sudden appearance of some new **entity**.

This neologism has been seldom used. It is obviously the opposite of **catastrophe**. According to the catalan systemic historian P. VOLTES BOU, it has been introduced by C. RENFREW (Pers. comm.)

→ **Dissipation; Emergence; Thermodynamics; Zero-System**

0120

ANDRAGOLGY ¹⁾³⁾⁴⁾

The discipline that studies human **action**. Andragology is a creation of Gerard de ZEEUW and has been developed by him in Holland at the University of Amsterdam, as well as in conferences organized by the **Systeem Groep Nederland**; and in the journal *Systemica* of which he was editor in chief. Martha VAHL, a close collaborator of de Zeeuw, writes "Andragology... combines interests both practical (adult **education**, social helping, support through the built **environment**) and theoretical (the acquisition of supportive **knowledge**). In terms of the breadth of this definition, andragology, as a field, remains more or less unique to the Netherlands" (2002, p. 101)

This reference to the Journal "Systems Research and Behavioral Science" is a fundamental one about de Zeeuw and his collaborators work, being a Festschrift in his honor.

The same issue also offers a listing of de Zeeuw's publications compiled by M. Vahl and, generally, an abundant bibliography of the field.

→ **Conversation; Facilitation; Perspectivism**

0121

ANIMAT ¹⁾⁵⁾

An artificial **organism** whose **structures** and **processes** are as similar as possible to an animal ones.

The problem is however in the way an animat acquires such **structures** and **processes**.

There are three possible **models** of animats (at least!)

- animats can be made to learn **behaviors**.

This can be done endowing them with a **neural network**, thus making them adaptive

in a range of experimental situations through a **set** of interacting **rules** organized as to cope with external **changes** that may have an impact on the animat

- animats can be made evolutive. Again this can be obtained through an appropriate neural network and a set of rules. But the need for **evolution** can be installed by introducing a measure of **randomness** in the **rules**.

However, none of these animats models seems to tackle all the aspects of modelling animal **behavior**, specially "intelligent" beings.

E. VACCARI and M. D'AMATO write: "**Cognitive systems** are composed of multiple **sub-systems** which are simultaneously active and interacting. Their cognitive **behaviors** are pervaded by both continuities and discreteness and their kind of **structures** emerge over time. Further **cognitive processes** operate over many **time scales** and **events** at different **time scales** interact" (2000, p. 173)

In short, a good animal model should never become an **homeostat** in the sense of ASHBY.

Or, even the existence of **constraints** cannot totally prescribe all the modalities of **change**, and still less, stop **change** altogether.

Already in the 18th century LEIBNIZ (1646-1716) stated that any **change** in one **element** in an entity is conducing to modifications of all the other **elements**. Such a **process** takes necessarily place at multiple **levels**, in different ways, at variable **time scales**, and can thus be modellized only in a conjectural and imperfect way, be it for an animal, or an animat.

0122

ANIMORG ¹⁾

"A type of self-adaptive system that has the properties of complex **organization** in **dynamic equilibrium**, **regulated behavior**, and the ability to change, grow and reproduce"

This term, introduced in 1940 by R. GERARD, corresponds more or less to J. MILLER's "**living system**", but did not met with wide acceptance. (1956, p.158; 1974, p.121)

As a subclass of animorgs, GERARD distinguished "**epiorganisms**", i.e. **colonies** or societies made of individuals. (1956, p.158)

0123

ANISOCHRONICITY

→ Isochronous

0124

ANISOTROPY ²⁾

Character of any entity whose properties vary in line with different directions.

Any system is more or less anisotropic, generally very much so. Anisotropy is closely related to **structure** formation and maintenance, and reflects **disymmetries** resulting from **symmetry-breaking**.

0125

ANTAGONISM PRINCIPLE ²⁾

"Every system results from two antagonistic forces mutually binded" (S.LE PEUTREC & M. COURANT, 1994, p. 1550)

The principle was originally proposed in France by S. LUPASCO (who constructed a "logic of contradiction" – 1947): "It is antagonism, i.e. the coexistence of forces that attract o repel each other, or **conflict** with this attraction, that constitutes the fundamental mechanism, sine qua non of the physico-chemical **objects**, with more or less strong domination of some of them over the others... It is the nucleus where the antagonistic forces become most strongly equilibrated that constitutes the most resistant system, the one... most difficult to disintegrate" (1972, p.100)

Under this somewhat philosophical guise, it is easy to recognize C. LAVILLE's, or K. DE GREENE's, or D. Mc NEIL's views about **inter-acting fields**, or **vortexes**, or **toroids**, or H. SABELLI's theory of **processes**, all of which are basically **dynamic**.

LUPASCO, significantly, used the words "attract" and "attraction", long before **attractors** became a pass-word in so many systemic **models**.

In systems, we may observe the antagonism principle, for instance in **environment-system** antagonism, or inside of a system, the construction-destruction antagonism.

According to LUPASCO, the principle is rooted in a reflexive combination of the 2nd Principle of **thermodynamics**, that prescribes the increase of **entropy**, and PAULI's **exclusion principle**. LUPASCO gives as examples the **development** of an embryo, or the shaping of a hurricane; still another important research on the subject has been d'ARCY W. THOMPSON's on "Growth and Form" (1916)

LUPASCO also stated that "the antagonism principle appears...as the formation principle of any system, as well as the bedrock of systems logics" (1982)

0126

ANTHROPIC PRINCIPLE ³⁾

J.D. BARROW and F.J. TIPPLER formulated this principle (1986). According to them, the nature of the physical world must necessarily be such that the perceptive and intelligent **observer's** existence be possible.

A **universe** without witnesses would of course be a different **universe**... or would it "exist", i.e. is existence possible without self-**consciousness** (even of a **part** observing the **whole** – or at least a larger fragment of the **whole**)?

It is difficult to evaluate the possible systemic **meanings** of these recollections from PLATO and BERKELEY. Whiffs of **solipsism** are floating around!

A more acceptable view of the Anthropic Principle would be that the **coherence** of multiple characteristics of the universe as we know it (microphysic and macrophysic constants, **space-time** characteristics, gravitation, etc.) merely implies that our own existence as conscious **observers** (after a very long evolutive **process**!) became possible, or even normal.

But this kind of extraordinary stretched cosmical **tautology** does not lead to any new and significant rational **development**. It may be more useful for theology than for science. (WALD, 1994, p. 123-31)

0127

ANTHROPOCENTRISM ¹⁾³⁾

The mental attitude and worldview that tends to interpret **facts** as significant only or merely in relation to man or mankind.

Of course, it would be probably impossible to do otherwise. However, as the self-understanding of specific people depends of the historical (or transient) circumstances, the anthropocentric view should be carefully and permanently scrutinized. Indeed even the most abstract **concepts** and **models**, as well as the supposedly "objective" **observation** remain necessarily products of the human senses and mental organization.

From the Ptolomeic cosmology to the so-called **anthropic principle**, we should all be always ready to recant from our own imaginations and illusions. **Conversation**, reciprocal critique and Popperian **falsifiability** are tools that should be put to more frequent use.

→ **Culturocentrism**

0128

ANTHROPOMORPHISM ¹⁾⁴⁾

The attribution of human characteristics, **behavior** or motivations to animals, physical **events** or imaginary beings (good or evil spirits, gods).

Considering its universality, anthropomorphism could be, according to J.Z. YOUNG (1978, p.289), a clue to an inherited **brain program**.

0129

ANTIBIOSIS ⁵⁾

An antagonistic relation between two types of **living systems**.

When two species are in such a **relation**, one species may eliminate the other. A variety of antibiosis is allopathy, where a species produces some toxic substance which impedes other species to establish or maintain themselves.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

0130

ANTICHAOS²⁾

A **process** through which "some very disordered systems spontaneously "crystallize" into a high degree of **order**" (After St. KAUFFMAN – 1991, p.64)

According to KAUFFMAN: "Computer **models** suggest that certain **complex systems** tend toward **self-organization**" (Ibid). The subject is closely related to the **behavior** of **composite systems** and their **self-organized criticality** (developed by P. BAK et al. in 1988; 1989; 1991).

It is not however the true antithesis of **chaos**, since **chaos** does not generally disorganize **complex systems**: it only makes the prediction of their **behavior** quite difficult, or downright impossible.

0131

ANTICIPATORY BEHAVIOR→ **Behavior (Anticipatory)**

0132

ANTICIPATORY SYSTEM¹⁾²⁾⁴⁾

A system able to define its own **goals**, or at least able to behave in order to tend in a permanent way to maintain itself in the future.

Human beings are more or less conscious of their **goals** and in many cases able to define and describe them. In other living beings the **goals** remain implicit and probably totally unconscious.

The study of anticipatory systems is quite difficult. B. EKDAHL writes: "Anticipatory systems are a result of **evolution** and the characteristic of them is that they consist both of **description** (genotype) and **interpretation** (phenotype). Many such systems are not conscious of their own interpretations and can be regarded as having only a built-in theory and no **language** in which its interpretations is described. Such systems show an algorithmic **behavior** and can be simulated on a **computer**."

"Systems which can also make a (**semantic**) **model** and moreover have a possibility to reason about this **model** cannot be reduced to computation since in no other language its **interpretation process** can be described than in the **language** itself.

"As a consequence, model-based anticipatory systems cannot completely be described by mathematical means but have to be **holistically** considered in order to give a reasonable **explanation** of their **behavior**. The way to look upon a system as a mathematical **structure** is not applicable in such cases" (2000, p. 13)

0133

ANTISYNCHRONY²⁾

The condition of two **oscillators** which are half a **cycle** out of **phase** with each other.

J. COLLINS and I. STEWART write: "The anti-synchronous motion has its own **symmetry**: the **oscillation pattern** is unchanged if the two **oscillators** are interchanged and their respective **phase** shifted by half a **cycle**"

Furthermore: "Coupled **networks** of three or more **oscillators** have more complicated **oscillation patterns** that just **synchrony** and anti-synchrony and some of these **patterns** are highly **counter-intuitive**" (1994, p.39)

0134

ANTISYSTEMIC WAYS¹⁾

Linear thinking is still widely practiced and leads to the illusion that a specific **issue** of problem can be isolated from **context** or **environment** and "solved" through some specific intervention, without any **side effects**. In this way a double problem appears:

1) the issue is artificially simplified and, as a result, misunderstood

(J. WARFIELD's **underconceptualization**)

2) **side effects** do indeed appear, and in some cases introduce new problems that may even be worse than those whose solution was sought.

Some are very dramatic, as for example:

- the Aral Sea disaster due to an ill-conceived river harnessing and an irrigation program that took no account of the possible effects on the **environment** of the whole region.
- the growing resistance of all kinds of pests to chemical insecticides, with for ex. the appearance of "super-mosquitoes" able again to propagate various illnesses that were thought to be controlled (Malaria, yellow fever, etc...)
- the growing resistance of pathogens to antibiotics and chemical medicines (Tuberculosis, malaria, hospital infections)

This does not mean that new ways to manage these **issues** (and many others) should not anymore be researched and used. It means that we need to become better chessplayers with nature and, specifically, that we should abandon our narrow views neatly characterized for ex. by the well known motto "**et ceteris paribus**", because, of course the conditions are never twice absolutely the same; or the illusions that any **event** has only one **cause** and produces only one **effect**, or yet that **predictability** is always perfectly and completely possible.

The **systemic approach** is becoming a full need in the complex world that we pretend to manage.

0135

APOMORPHY^{2) – 3)}

The appearance of a new characteristic, derived from a former one, in a **group** of living **organisms**, leading to the recognition of one and only one new **group**.

The concept of apomorphy is basic to the **taxonomy** of living **organisms** known as **cladism**. A particular group of apomorphic characters is what defines a clade.

0136

APOPTOSIS¹⁾⁵⁾

The **process** of **self-destruction** of the **cells** in the living **organism**.

Apoptosis is a very general **process**, active even at the embryological **level**, where it seems to be important for the progressive construction of the definitive **form** of the living being.

Every biological **element** or individual appears to include some **timer** device. The ways of apoptosis are becoming better known, but its deeper cause or causes remain obscure.

Its relation to **autopoiesis** as well as to **ageing** should also be researched more thoroughly.

This biological **process** discovered quite recently seems to imply a more general systemic **meaning**. It could mean that the need for the system to self-reproduce at its **level** of **complexity** corresponds necessarily to a longer **life time dimension** which is out of reach of its **elements**. This would be more generally an expanding **time dimension of complexity**

Human societies, for example, considerably supersede the living **limits** of their individual **components**, whose **ageing** seems to be commanded by some biological clock, i.e. a **timer**.

(For more on biological **apoptosis**, see "Science", Special issue, 281, nr.5381, 1998).

0137

APPEARANCES³⁾

G. BATESON observes: "Always the **process** of **representation** will filter out the *Ding an sich* – i.e the **object** in itself, so that the mental world is only **maps** of **maps** of **maps**, ad infinitum. All '**phenomena**' are literally 'appearances'" (1967, p.429)

The same view was developed as early as 1933 by A. KORZYBSKI in "Science and Sanity" → "**Structural differential**"

0138

APPRECIATIVE SYSTEM³⁾

"The interconnected **set** of largely tacit standards of judgement by which we both order and value our experience" (G. VICKERS, 1973, p.122).

According to VICKERS: "... the **components** of **human systems** – active individuals attributing **meaning** to their **situation** – make it impossible to study such systems using the **methodology** of natural sciences. The only way to understand **decision making** in **human**

systems is to understand the different appreciative systems that the **decision makers** bring to bear on a **problem**" (M.C. JACKSON, 1992, p.135)

And... "It follows, according to VICKERS, that if **human systems** are to achieve **stability** and **effectiveness**, then the appreciative systems of their participants need to be sufficiently shared to allow mutual expectations to be met. **Human systems** depend upon shared **understandings** and shared cultures" (Ibid)

In each culture, specific **values** and **norms**, transmitted through successive generations by imprinting, **learning**, teaching and training produce the equivalent of **organizational closure** in biological systems.

This is reflected in the so-called "Culture of the enterprise", the French "Esprit de corps", the Spanish "Espíritu de la colmena", the German "Gleichschaltung" and many other similar expressions related to cultural or ideological unifying (and dividing) appreciative mental and psychological frameworks.

→ **Semantic reaction**

0139

APPROACH ¹⁾²⁾

"An internally coherent and theoretically grounded collection of **models**, **methodologies**, **methods**, and **tools** used to learn about the world and to act in it" (K. BAUSCH-Glossary of terms- personal communication)

BAUSCH adds: "It is a flexible and creative way of engaging in a disciplinary **inquiry**" "However the **cybernetic** and systemic "tools" are mostly **transdisciplinary** because they are in fact "meta-tools" i.e. they can be applied in a similar way in many disciplines."

As an example **feedback** as a tool (or a **model**, for that) is a very general **mechanism** that can be recognized and used in all **nonlinear situations**, wherein a cyclical **loop** exist in the form **cause-effect-cause**.

0140

APPROACH (Analytic versus Systemic) ¹⁾⁻³⁾

The cutting edge of the systemic approach is thus stated by M. BUNGE: "A systemic approach to any subject boils down to abiding by the principle that every **object** is either a system or a **component** of a system. The methodological consequence is obvious: Nothing can profitably be studied in isolation" (1993, p.210).

J.de ROSNAY explains as follows the differences between the two approaches: "The analytic and systemic approaches are **complementary more than opposed**. However they are not reducible to each other. The analytic approach aims at reducing a system to its most simple constitutive **elements**, in order to study them in detail and understand the types of **interactions** which exist among them" (1975, p.109)

A good example is the study of the **components** of water and the way they associate: H²O is one bivalent O associated to two monovalent H, due to complementarity of electronic shells.

"Next, one modifies one **variable** at once to try to deduce general laws permitting the **prediction** of the systems properties in very different conditions. In order to be able to obtain such **predictions**, the laws of **additivity** of elemental properties must be valid. This is the case with **homogeneous systems**, i.e. those whose **elements** are similar and present weak reciprocal **interactions**. In this case, statistical laws can be applied and produce an **understanding** of the mass, i.e. of **inorganized complexity**" (Ibid)

In this dictionary, "inorganized complex systems" are named "**composite systems**" and their **behavior** is considered under the heading "**Criticality**". "The **additive** laws of elementary properties are obviously not anymore valid in the case of highly **complex systems**, made of a very great diversity of **elements**, linked by strong **interactions**. Such systems must be tackled with new **methods**, such as those of the **systems approach**. Their **goal** is to consider a system as a **whole**, with its proper **complexity** and **dynamics**. By the use of **simulation**, for example, it becomes possible to "animate" the system (i.e. its **model**) and to observe in real **time** the **effects** of the various types of **interactions** between the **elements**" (Ibid) This is done by FORRESTER's **Systems dynamics**, which is a powerful tool, but has also its weaknesses, for example about the real possibility to modelize **simultaneity** of **effects**.

"The study of its **behavior** in **time** leads to the determination of **rules** for **action**, whose aims are the modification of the system or the conception of new ones. Better than a point by point **description** of the characteristics of both approaches, it seems more useful to oppose them in a (comparative) table, not starting... a debate about their respective advantages or drawbacks" (Ibid) see table right column

"This table, useful because of its simplicity is however no more than a caricature of reality. This too dualistic **representation** locks thought up within an alternative, apparently difficult to avoid. Many other comparison points should be mentioned. However, while not exhaustive, the table is useful by defining two complementary approaches, of which one (the analytical one) has been favored in a quite disproportionately large way in our whole education" (1975, p.110)

Within the systemic approach itself, R. RODRIGUEZ DELGADO distinguishes three aspects, as follows:

"a) Static approach

Systems basic **structures**, **Components**, **Subsystems** and **elements**.

Analytic approach

Isolates: centered on **elements**

Observes the nature of **interactions**

Relies on precise details

Independence from time;

Phenomena are considered **reversible**

Modifies one variable at once

Validation of facts obtained experimental proof within a theoretical **frame**

Precise and detailed rigorous **models** difficult to use in **action** (for ex. econometric models)

Approach is efficient when **interactions** are weak

Leads to a disciplinary teaching (juxta-disciplinary)

Leads to a detailed **programming**

Produces a good **knowledge** of details; but ill defined **goals**

Systemic approach

Connects: centered on **interactions**

Observes the **effects** of **interactions**

Relies on global **perception**

Integrates duration and **irreversibility**

Modifies simultaneously groups of **variables**

Validation of facts obtained by comparing the way the **model** is working, with reality

Models are not enough as bases for **knowledge** but are **useful for decision and action** (for ex. The Club of Rome models)

Approach is efficient when the **interactions** are **non-linear** and strong

Leads to a **multi-disciplinary teaching** (Should lead to a **transdisciplinary** teaching)

Leads to an action aimed at **goals**

Leads to **knowledge** of **goals**, but ill defined details

Communication channels (System's Anatomy)

"b) Dynamic approach

System and **subsystems** functions. **Relationships** with **suprasystems** and **ecosystems**. Organic **cycles**. **Homeostasis** (System's Physiology)

"c) Dialectic approach

Reproduction of systems. Mutations. **Structural transformation**. **Selforganization**. (System's **ontogeny**) – Individual **transformation** and phylogeny – Apparition of **emergent species** or **models**

"Research into these complementary aspects open new possibilities to transform **environmental** conditions, human **organizations** and systemic **goals**, making easier the elimination of **constraints** and limitations" (1993b, p.32)

Of course, such positive aspects become possible because of a better previous **understanding** of these limitations and **constraints**, some of which may correspond to unavoidable and even in some cases, desirable (while misunderstood) conditions. Let us avoid any triumphalism.

0141

APPROACH (Hazards of the systemic) ³⁾

Joel de ROSNAY describes in the following way some distortions which could discredit the **systemic approach**:

"In order to better dismythify the **systemic approach** and allow it to maintain a **transdisciplinary** attitude and a training for the **control** of **complexity** and **interdependence**, should

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

we not even reject the very term of **systemic approach** or **method**? Everyone can learn to "stand back". Global vision is not a preserve of the great managers, the philosophers and the scientists. To learn the use of the **macroscope**, to apply the systemic **rules**, to build more rigorous mental **models** and even to be able to control the interplay of **interdependences** (can be done)".

"But we should not occult the hazards of a too systematic use of the **systemic approach**. A purely descriptive approach from the exclusive relational angle leads quickly to a useless collection of **models** of the different natural systems. The excessive generality of the systems concept may also be turned against it. Its fecundity may be destroyed by sterile **triviality**. All the same, the ill controlled use of **analogies**, **homologies** or **isomorphies** may lead to some complicated in spite of clarifying interpretations because they are based on superficial **similarities**, more than on basic principles and laws common to all systems. According to E. MORIN, "too much unification risks to lead to abusive simplifications, obsession and thought recipes".

"Once more we are threatened with the dogmatic danger if we draw the systemic approach back to an intransigent systemism or to a **reductionist** biologism. We are threatened by the seduction of **models** conceived as results of insight instead of starting points for research"

"One of the worse risks which threatens the **systemic approach** is to be tempted by a "unitary theory" (a "theory of everything"), an englobing **model** which should have a solution for everything and could predict everything. The use of the mathematical **language** – generalistic by its nature and vocation – may lead to a formalism apt to isolate the **systemic approach** instead of opening it to practice. The "General Systems Theory" barely escapes to this risk: at times it secludes itself within the **theory of graphs** languages, the **theory of sets**, the **theory of games**, the **theory of (quantitative) information**, at times it becomes no more than a **set** of descriptive approaches, many times quite illuminating, but devoid of practical applications.

"The operative **systemic approach** is one way to reach beyond these alternatives. It avoids the risky pitfalls of paralyzing **reductionism** and englobing systemism. It opens the way towards **knowledge transmission**, **action** and creation.

"About **knowledge transmission**, the **systemic approach** offers a conceptual **reference frame** which helps to organize **knowledge** in the course of its acquisition, reinforces its memorization and make its **transmission** easier.

"About **action** it enables to obtain **rules** to approach **complexity** and allows for the correct location and **hierarchization** of **elements**, basic for **decision making**.

"Finally about creation, the systemic approach catalyzes imagination, **creativity** and invention. It supports inventive thinking, while the analytic approach supports inquiring thinking. Systemic thinking should be tolerant and pragmatic, open to **metaphor**, **analogy** and **model**, formerly excluded from the "scientific method" and now rehabilitated. For the systemic approach, anything which ends partition of **knowledge** and releases imagination is welcome: it should be open, just as the systems it inquires" (1975, p.128-30)

0142

APPROACH (The Ten Commandments of the systemic)^{1) - 2)}

J.de Rosnay enumerates as follows the "10 Commandments of the Systemic Approach"

1. To keep **variety**
2. Not to open the **feedback loops** (i.e. not destroy the **regulators**)
3. To seek the **amplification** points
4. To establish **equilibria** through decentralization
5. To maintain **constraints**
6. To differentiate in order to improve **integration**
7. To evolve, by reaction to aggression
8. To prefer **objectives** instead of detailed **programming**
9. To know how to use **energy** (contained within **information**) for **management**
10. To respect **reaction delays**" (1975, p.122-127)

It is obviously possible to imagine other "commandments", less limited to human systems and, of course less operative, as for example:

- to define as precisely as possible the significant **environment** of the system
- to clearly define the main **objective** of the system and its subsidiary ones
- to find out the different **rhythms** of **activities** of the system and discover their interrelations
- to determine the degree of maturity of the growing system: just born, or emergent, in **steady state**, or in the **process** of **sclerosis**.

0143

A PRIORI (Kantian)³⁾

F. GONSETH discussed the validity of KANT's (1724-1804) a priori, when viewed as an absolute and unquestionable beginning for philosophy. He did not accept that "the debate is closed even before starting" when it is admitted that a priori are the "sine qua non of all

knowledge and judgements" as they set the very forms under which **experience** must unavoidably manifest to us" (1955a, p. 6)

In fact "compare a priori with the results of **experience** (of whatever kind) is simply compare them with themselves. Nothing can emerge of this, if not that they must be as they are"(Ibid)

Indeed, the a priori is established by the **observer** (supposedly being the infallible philosopher) within his own **frame of references** and we are led to the **autopoietic** critique of the ways we observe **reality** and of what **observation** amounts to in these bio-psychological terms.

In short, no a priori can establish an absolute starting block, being out of reach of falsifiable research of any kind.

0144

ARC⁵⁾

→ **Graph**

0145

ARCHETYPE¹⁾

The sum of interrelated characters, accumulated through **time** by former systems, which defines the basic **structures** and **functions** of a new system of the same kind.

Any archetype is a more or less abstract **model**, whose concept is Platonian in nature.

G. BATESON calls it a "**genotype**" and defines it as a "body of **memories**", as he refers himself basically to biological systems.(1973, p.287)

Nobody has ever given a definitive and rigorous explanation about the way archetypes become established. As to BATESON's "body of **memories**", F. DAVID PEAT connects in a hypothetical way Jungian psychoanalytical archetypes with the **hierarchic structure** of the **brain** which is "...often pictured as containing a series of evolutionary **levels** beginning with its primitive reptilian **brain** stem and working upward to the higher primate functions of the cortex. In addition, there are probably a number of evolutionary remnants present in the chemical pathways of the various neurotransmitters, peptides and other chemicals used in the **brain**" and while "such arguments contain more speculation than facts (they) suggest that the unconscious mind arises out from a more primitive **layer** of the **brain** which is not yet capable of secreting "higher" conscious thought" (1988, p.107).

It is anyhow undeniable that dogs engender dogs and cats, cats; and that such is the base-ment of identity and **organizational closure** in systems.

→ (see also: **Ideal-type**)

As explained by C. WADDINGTON, through his concept of **epigenetic landscape** (1977), evolutive **change** of an archetype does never occur freely in a vacuum.

As a result of its archetypical inheritance, any **organism** is endowed with *limited* (even if within a considerable potential for **adaptability**) possibilities of development from its **auto-genesis** on, and is thus able to construct itself only through a *pre-constrained morphogenesis*, in **interaction** with its **environment**.

0146

ARCHITECTURE (von Neumann's)

→ von Neumann's architecture

0147

ARGENTINE ASSOCIATION FOR GENERAL SYSTEMS THEORY AND CYBERNETICS ¹⁾

This Association was created in October 1976, originally under the name of Study Group of Integrated Systems. It was the first systems society in Latin America. Its main objective is the study and the diffusion of systemics and cybernetics through lectures, tutorials, seminars, and production of series of translations, and original papers and booklets ("Cuadernos", of about 100 pages each)

It organizes seminars and study groups on more specific subjects, or for disciplinary groups. Since 1992, an annual meeting gathers Argentine systemists and cybernetists, around some specific subjects. The Association also promotes visits of foreign systemists.

It published in 1992, in Spanish, the first Dictionary of Systems and Cybernetics, in collaboration with the **Instituto Andino de Sistemas** of Perú.

0148

ARGUMENT (Ad hoc) ³⁾

An hypothesis or conjecture introduced to solve an hitherto insoluble problem.

One wonders if some hypotheses very far away from **common sense** and not verifiable, introduced for example in some scientific **theories**, are not simply a way to "get out of the trouble". Changing the basic conditions of some **phenomena** and/or **theories** does not seem a very satisfactory option. (See John BARROW: "Is nothing sacred?", 1999).

These doubts were already aired by the French philosopher and epistemologist G. BACHELARD (1884-1962) ("La Philosophie du Non", 1949).

It is however doubtless that the very different **abduction** (PEIRCE) (1839-1914) is highly valuable in terms of **creativity**. Without the resulting "educated guesses", **knowledge** in general, and science in particular, would remain finally bogged down into static conservatism.

The difficulty is to differentiate **abduction** at its incipient state from useless imagination.

An example of genial **abduction** was WEGENER's (1880-1930) idea of continental **drift**, whose value was only recognized various decades later.

0149

ARGUMENTATION ANALYSIS ¹⁾²⁾

An ordered **presentation**, preferentially in graphical or matricial form, of the various significant opinions that can be identified on some **issue**.

This **method** can be very useful in order to avoid what J. WARFIELD calls "**underconceptualization**", "**clanthink**" or more generally muddled thinking.

It provides a sound foundation for **conflict** resolution, **conversation**, negotiation and **design**.

0150

AROGENESIS ¹⁾⁵⁾

An emerging jump in an **evolutive process** (W. SCHWEMMLER, 1991, p. 152)

0151

ARRAY (Activity) ²⁾

A **set of data** relative to a system's **behavior** organized in the form of a two- or three-dimensional **matrix**. (After G. KLIR, 1975, p.154)

G. KLIR uses such arrays – which can be processed – for experimental research.

0152

ARTICULAR RELATION ²⁾

Any **connection** device that provides a number of **degrees of freedom** in a **relation** between two **elements** or **structures**.

This notion was introduced by the French physiologist P. VENDRYES (1973, p.88) and is a generalization from the articulations between bones.

VENDRYES explains that no movement would be possible if bones were rigidly united. Freedom of movement depends on the possibility to adopt a number of different relative positions, as flexion, extension, rotation, etc... However movement could not be coordinated if the **relations** were totally undefined. The ligaments and their **connections** with the bones and muscles provide a more or less extensive **program** for mobility **relations**. This **program** is framed within defined **determinisms**, but, at the same time, within this **frame** it allows for a **variety of combinations**, and much more so when there is a **chain** of articular relations, as for example from the shoulder to the fingers. In VENDRYES terms: "Thanks to its elasticity, a muscle admits articular **indeterminism**; by its contractibility it imposes a **determinism**" (p.90) As a result, a number of more or less

random options do exist. But any defined movement selects only one and thus imposes at some moment, in some situation and for a limited **time**, a specific **determinism**.

According to VENDRYES the articular relation concept can be generalized to any relation wherein a number of undefined possibilities co-exist, but where only one can be selected (excluding all others) at any specific moment.

As an example, he gives the articular relation between words in a **language**.

The **analogy** with **decision** mechanisms in general is also striking.

0153

ARTIFACTS ¹⁾

"Things fashioned by rational beings with the help of some technique whether primitive or advanced" (M. BUNGE, 1979, p.209)

BUNGE comments: "An artifact is not just one more thing but a thing belonging to a kind that did not exist before the **emergence** of man or some other rational being. Artifacts may be regarded as constituting a whole new **level** of reality, namely the **artiphysis**... Artifacts are at the heart of human society and have properties absent from natural things" (Ibid).

It should however be remembered that the beginnings of rationality are ill-delimited: some apes make and use very simple artifacts, and also some Galapagos finches observed by DARWIN. Even spider's webs or beehives could be considered as artifacts constructed either by individuals or by collectivities, not obviously rational in the commonly accepted sense.

Construction of artifacts seem to be a **living systems'** capability still in full course of **evolutive development**.

The multiplication of artifacts deeply transforms the relation between man and the planetary **ecosphere** because it tends to create a global human **invironment** more and more distinct from the global **environment**.

The same **effect** is also present at more local **levels**: we are becoming "synthetic fishes in a plastic aquarium", with ever lessened contacts with our natural **environment**.

0154

ARTIFICIAL EVOLUTION

→ Evolution (artificial)

0155

ARTIFICIAL INTELLIGENCE ^{3) - 5)}

"The creation of **algorithms** and systems that exhibit intelligent **behavior**, including activities such as adaptive and **heuristic programming**, cognitive **process modelling**, **expert systems**, natural **language** processing, and **neural networks**" (G. FORGIONE, 1991, p.64)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This definition covers a wide area of quite different subjects. It is much more than, in K. KRIPPENDORFF's words: "A branch of computer science concerned with the **programming** of computers so that they exhibit apparently intelligent **behavior**, e.g. the **design** of **robots**, chess playing **automata** or theorem proving machines" (1986, p.4)

The "apparently intelligent **behavior**" conforms to the **TURING's criterion** according to which a "**machine**" should be considered intelligent if an **observer**, unknowing that she/he is dialoguing with a **machine**, cannot differentiate it from a human being.

According to M. MINSKY, an A.I. device must have an **understanding**, at least rudimentary, of its own **problem solving processes**. He believes that, if one endows it with a **model** of its own workings, it could finally improve itself.

This seems questionable, at least for two reasons:

- **GÖDEL's Incompleteness theorem** may not allow any system to contain a complete **model** of itself.
- If the **model** is introduced from outside, the predominance and necessity of natural intelligence is reestablished.

FORGIONE's definition reflects the evolution of the field, already observed in 1980 by M. BODEN who wrote that: "Artificial Intelligence cannot be expressed in the terminology of traditional **cybernetics**, which focusses on **feedback** and adaptive **networks** and which defines **information-processing** in quantitative rather than qualitative terms" (1990, p.30)

E. ANDREEWSKY states: "Two main axes which, to judge by current debates, appear to be **antagonistic**, characterize the **cognitive models** of Artificial Intelligence: the so-called '**classical**' Artificial Intelligence where **cognition** is considered from a "software" viewpoint (insofar as it concerns, as in computer **programs**, "computation" on **symbols**) and **Connectionism** where **cognition** is considered as if "emerging" from the **brain** and its neurons. These axes define different, but nevertheless very complementary, points of view on mind" (1993, p.189)

And "**Connectionism** is considered by the tenants of classical Artificial Intelligence as a resurgence of **Behaviorism**, with the negative connotations associated to this approach. For **connectionists**, classical Artificial Intelligence is merely a "Spanish inn", insofar as the **rules** (or the meta-rules) of reasoning are given to the system" (p.194) (Note: In Spanish inns of old you were supposed to find only what you brought in yourself)

In fact, the classical view on A.I. implies that no intelligent system can work without a **program** of **algorithms**, i.e. a software. This is probably true, but how are these very **algorithms** constructed?

The **connectionist** answer tries to explain this point through the concept of "spontaneous" upbuilding of **patterns** from unplanned **interconnections** in the **network**. Furthermore, the **representations** acquired by the **network** are seemingly spread out over the whole **network**, in a kind of **holographic** way. But how do these **patterns** become fixed and how are the **rules** to construct the **network** generated? The very general topic of **order** from **randomness** lurks behind these question marks.

The problem seems to be closely related to the **autogenesis** one and, as said by ANDREEWSKY, *both* viewpoints are probably needed. Remains to be seen how they can be interconnected and integrated.

→ "**Power laws in fractal structures**" and "**Autogenetic systems precursors**".

Still a different angle is generalization through **induction**, as for example in the famed BACON program which "rediscovered" several classic physical laws: KEPLER's law of planetary motion; NEWTON's law of gravitation and BOYLE's law of gases, among others.

Generally speaking, D. GREGORY describes as follows what he calls the basic "realist" axioms, **problems** and **goals** of A.I.

"Axioms:

- **Knowledge** is a commodity. We can trade it, teach it, learn it, forget it, remember it, represent it, discover it...
- **Knowledge** is distinct from its knower – just like **data** are distinct from computer disks
- **Knowledge** is **sets** of true **facts** together with **rules** for combining them
- **Knowledge** can be reduced to **sets** of primitives – just like **matter** is ultimately reducible to fundamental particles" (1993, p.67)

(All these views are controversial, some of them highly so: **Knowledge** should be only acceptably understood here in T. ÖREN sense (see "**Knowledge (Taxonomy of)**")

"Problems:

- To elicit **facts** that are free of the distortions produced by the way they are known or described
 - To represent **facts** and their inter-**relationships** so as to capture the way the world really is
 - To specify a utilization engine that arrives at conclusions that are true in the world" (Ibid)
- (The words "**facts**", "**really**" and "**true**" should be carefully pondered in order to cautiously relativize their use. See for example "**Club of Rome**" models and "**Systems dynamics**")

"Goal:

- To build an Artificial Intelligence: a disembodied, artificial subject matter expert with whom **conversations** are possible" (Ibid)

D. GREGORY's conclusion is that "A.I. research seeks to understand the principles by which pragmatically and **semantically** interesting **behaviour** can be produced with **syntactic** machinery" (p.63)

Such a **mechanistic** and more or less **reductionist** view is widely, but not universally accepted.

0156

ARTIFICIAL INTELLIGENCE: dogmas and metaphors³⁾

As stated by S. GOONATILAKE: "Broadly speaking, it could be said that there are two main aims of people engaged in AI research. The first is building 'smart' **machines** or what could be called 'technological AI'; the other aim of AI researchers is to build **models** of **cognitive processes**, thereby helping one to understand the mechanisms of the mind" (1991, p.108)

Both groups brought into the subject their specific preconceptions (or even prejudices)

P.R. MEDINA MARTINS and L. ROCHA consider that the following dogmas have, until quite recently, "framed not only the kingdom of artificial systems but also – more deeply – their designer's minds:

- the dogma of the logical mind
- the dogma of the disembodied mind
- the dogma of the timeless mind
- the dogma of the adult **observer**
- the dogma of **objectivity**
- the dogma of the "in" and the "out" (1992, p.683)

These dogma are rooted – according to the authors – into two main interrelated **metaphors**, i.e. "the **brain** as a *serial* computer" and "the mind like a computer"

The implicit use of this conceptual **frame** led to **reductionist** views on human **brain** and intelligence, which created a number of senseless problems in psychology and also brought artificial intelligence to a conceptual dead end (If and when one admits that A.I.'s only aim is or should be to mimic natural intelligence, which is not obvious). Gigantic, but rigid basically sequential **algorithms** can obviously not replace nor reproduce the simultaneous and parallel workings of **neural networks**, notwithstanding the fact that sequential computers and some **expert systems** obtain specific results which are out of reach of natural intelligence.

As noted by G.J. DALENOORT: "... artificial intelligence went on for some twenty years in constructing **programs** that could do something that on the outside was similar to what humans could do, without bothering at all how this capacity could have emerged in the human system" (1987, p.14)

As **meanings** are always "human" **meanings**, any **symbol** used in a classical A.I. **program** has necessarily been human constructed, and this also true for the **program** used, which is not endowed with anything more than rigid **binary logic**, sequently applied in a rigorously predefined way. **Binary** computers have thus no autonomous **learning** capacity and, consequently, are no satisfactory **metaphors** for natural intelligence.

0157

ARTIFICIAL LIFE⁵⁾

The creation of collective artificial units able to spontaneously construct complex **behavioral patterns** through **cooperation** and shared **information**.

Artificial life is, of course, not biological (Nothing to see with Dr. FRANKENSTEIN's creature). It is either computer modeled, or consists in devices assembled from mineral and electronic **elements**, which somehow mimic some **living systems behavior**.

The first A.L. device was Grey WALTER's **Machina speculatrix**, unfortunately merely considered at the time, as a kind of amusing **cybernetic** toy, after which it was forgotten for about 30 years (along with the French A. DUCROCQ's electronic foxes)

Artificial life is thus a quite new field of research. C. DELAYE et al in France, C. LANGTON's team in the U.S., L. STEELS in Belgium among others, are exploring "**cooperation** between distributed **agents** through **self-organization**" (STEELS, 1990).

Artificial life would be based, in terms of C. DELAYE and B. CORBARA on: "...reactive **agents** which would not possess any **representation** of themselves, nor of their **environment** and whose **behavior** is based on **stimulus/response mechanisms**" (1993, p.840)

This model is based on an **analogy** with some **colonial** animals, as for example **Dictyostelium discoideum**. However, until now no specific socialization factor, comparable to cyclical AMP, has been demonstrated to exist.

In any case, artificial life, just as the natural one, is basically a social **phenomenon**, with eventually (in the French researchers terminology) various **emergent levels** of **complexity**: collaborating **reactive agents** into super-agents, etc... (Ibid., p.841)

G. PASK has however argued that much of the qualities of **self-organizing systems** are determined by their fabric. As proteins are different from electronic chips, artificial life could be similar to natural one in the **self-organizing** aspects, but probably not much more than that.

→ **Automaton (Learning); Parallel Distributed Processing**

0158

ARTIFICIAL LIFE 2⁵⁾

The creation of new living **organisms** through the assembly in laboratory of new composite genomes.

This biological artificial life is widely different from either the creation of societies of cooperative **robots**, or **computer modelling** of possible artificial **organisms**.

Research in this field is just beginning at the Institute for Genomic Research of Doctors CRAIG VENTER and Claire FRASER in Maryland (The Economist, January 30th, 1999).

The possible development of this type of project should be closely monitored, in view of its considerable potential for revolutionary **transformations** in biology and **ecology**.

0159

ARTIFICIAL LIFE (The Seven Commandments of)¹⁾

The following is a shortened synthesis of the subject as presented by C. EMMECHE (1994, p.17-22)

"In its ambitious version, the **concept** of artificial life encompasses the following ideas.

"1. The biology of possible... artificial life deals with **life as it could be**... Biology today is only the biology of actual life. It must become a biology of any possible **life-forms**.

"2. **Synthetic method**. Where traditional biological research has placed emphasis on analyzing living beings and explaining them in terms of their smallest **parts**, the artificial-life perspective attempts to synthesize life-resembling **processes** or **behavior** in computers or other media.

"3. **Real (artificial) life**. Artificial life is the study of humanly created systems that exhibit **behavior** characteristic of natural **living systems**... They are designed by us. The **behavior** however is produced by the artificial life itself.

"4. All life is **form**. Neither actual or possible life is determined by the **matter** of which it is constructed. Life is a **process**, and it is the **form** of this **process**, not the **matter**, that is the essence of life.

"These four theses are related"

There are moreover "three additional commandments about the way in which artificial life must be constructed:

"5. **Bottom-up** construction. The **synthesis** of artificial life takes place best via a principle of computer-based **information processing** called "**bottom-up programming**": at the bottom many small units and a few **rules** for their internal purely local **interaction** are defined (This is the real **programming**). From this **interaction** arises the coherent "global" **behavior** at the general level: a **behavior** not previously programmed according to specific **rules**.

"6. **Parallel processing**. While **information processing** in a classical computer takes place sequentially ... the principle for **information processing** in artificial life is based on a massive **parallelism** that occurs in real life.

(Note: i.e., reflecting the **simultaneous activity** of many individual **elements**).

"7. Allowance for **emergence**. The essential feature of artificial life is that it is not pre-designed in the same **trivial** sense as one **designs** a car or a **robot**. The most interesting examples of artificial life exhibit "**emergent behavior**".

0160

ARTIFICIAL SELECTION

→ **Selection (Artificial)**

0161

ARTIPHYSIS¹⁾

The global **set** of **artifacts**

This neologism is used by M. BUNGE (1979, p.209)

The present research into "**artificial life**" gives a much wider dimension to BUNGE's assertion that artiphysis is a whole new level of reality. It could become a kind of globally organized artificial **ecosystem** whose future **relations** with the natural one opens a whole field of new questioning.

0162

ARTORG²⁾

Artificial organism.

This neologism has been sometimes used during the fifties and sixties. It was never widely accepted.

0163

ASCII Code⁵⁾

A basic **code** made of **bytes** that is used to represent a common **language** in a computer.

8 **bits**, each of it with the value 0 or 1 (or cells in a **TURING Machine**) make a **byte**. There are thus 2⁸, i.e. 256 possible distinct combinations, which is quite sufficient for example for common **alphabets**, with punctuation and special **signs**.

0164

ASILOMAR CONVERSATIONS¹⁾

The periodic meetings of a number of systemists in Asilomar, California.

The general goal of these meetings, originally inspired from the **Fuschl Group Conversations**, is to freely exchange views about specific human **issues** - as for ex. **education**, social **design**, social **organization**, social **awareness**, the future of societies, etc...

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

These conversations start with a general agenda, but develop in an open way through free debate in subgroups which define their specific agenda for the consideration of more precise aspects of the general agenda.

The conversations conclusions are not prescriptive, but could be called "inspirative".

0165

ASSESSMENT (Collective reciprocal)^{1) - 4)}

A process of reciprocal **perception** and/or **information** leading to a shifting collective **behavior**.

D.M. GORDON showed that work in the ant-hill is a collective **distributed process** based on an also collective **perception** of the global needs, arising out of shifting **tasks allocation**, which in turn arise out of numerous **interactions** between individuals. (1995, p.50-7)

This type of **processes** obviously would deserve a general systemic research, because it is probably present in all kinds of **social systems**, from cells to **human systems**.

0166

ASSESSMENT in systemic terms^{1) - 4)}

A. CASELLES proposes "a theoretical approach to all kinds of **forecasting** and **control problems**" considering "**General Systems Theory** ...specially adequate to the most difficult ones" (1993, p. 1285-89)

Applying his proposal to technology assessment, he suggests a **frame** "to begin the identification **process** of the **elements** and **connections** involved... in each technology assessment case", as well as a mathematical **model** taking in account the following factors:

- Required services depending on **population** implicated and on unitary demand respect to each service;
- **Population** implicated (based on a demographic **submodel**);
- Unitary demand (for example, all urban transport made by private cars makes the **unitary demand** of street surface higher than when public transport is used);
- Effective capacity to produce services;
- **Resources** to services; an **input variable** that enters the **resources** distribution among services, made by managers;
- **Resources** required by each technology;
- Offered services (producing an income);
- **Resources** consumption and **operation** (which produce a **cost**)"

R. PETRELLA (Director of the Program "Forecasting and Assessment in Science and Technology" of the European Union) writes: "... Technology Assessment is the **set** of procedures and **means** at the disposal of a society for the **understanding** of the nature and im-

pact of scientific mutations, development and uses of technologies and for research about their usefulness, their economical feasibility, their social relevance and value" (1993)

This confirms that assessment, specially in technological matters, is much more than a simple study of technical and economical adequacy of some innovation, confirming the usefulness of CASELLES' proposed systemic **methodology**.

However, his list of technical **criteria** should be expanded in order to take in account some other important aspects, as for instance: **Costs** of **resources** renewal, or impact of their exhaustion; impact on **ecosystems**; social benefits and **costs**; probable duration of usefulness, etc...

To make this clearer, CASELLES' **criteria**, if applied for example to the realization of the Kazakhstan irrigation scheme - which ruined the whole Aral Sea **ecosystem** and the human system depending on it - would have passed it with flying colors. The purely technical and economical **criteria** applied where wholly insufficient to predict possible **side-effects** of different types.

0167

ASSIMILATION¹⁾

Integration of external factors into a system's **structure**.

J.W. SUTHERLAND considers assimilation as the "complementary pole" of **accomodation**, which is merely a temporary or more or less lasting and reversible **adaptation** of the system to external variations.

The concept is somewhat difficult to conciliate with **autopoiesis** and **organizational closure**. Any system can assimilate only that which is compatible with its basic nature. Besides, assimilation seems possible only when the system still possess a high degree of **redundancy** (see **ageing**, **order from noise**).

Assimilation within the individual system, is *not* the mechanism, or at least the main mechanism, of **evolution**. This last comment commands however two caveats:

- The acquisition of new **habits** may well predispose in either a positive or negative way, the individuals of some species to the **transmission** of **dormant** or new traits.
- In the human species, mental assimilation of newly acquired **concepts**, **percepts** and symbolic associations seems to be directly transmissible through **communication**, something that KORZYBSKI called totalization through **time-binding** (1950b).

0168

ASSOCIATION²⁾

"The **relation** which is **commutative** and **connected**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.33)

Grains of sand which accumulate in a dune are related in an associative way, since this way is **commutative** (The **order** in which they accumulate is irrelevant), and **connective** (since no **element** needs of any intermediary one to be in contact)

Association is thus a simple, non-**structural** and non- **functional relation**, at least in the **meaning** proposed by FEIBLEMAN and FRIEND. It is here the most primitive and rudimentary form of **coordination** among **elements**.

It reflects however a **trend**, generally induced by common conditions imposed to the **elements** by the **environment**, as for example dominant winds on sand dunes.

The generally accepted sense in social psychology and sociology goes quite farther than this and includes the **results** of closeness, i.e. defined **interactions** in **groups** and **social systems**.

0169

ASSOCIATION (Potential for functional)¹⁾²⁾

The existence of conditions in **elements** that could allow for the **emergence** of significant **relationships** among them.

Good examples are the combinatory potentials of chemical **elements** as a result of the different **states** of the electron shells of their atoms.

0170

ASSOCIATIVITY²⁾

The propensity of **elements** to form **links** and create **networks** or **structures**.

The most elemental forms of associativity are seen in **composite systems** and in **colonies**, where **subsystems** are not yet clearly differentiated. Such forms tend however in some cases to evolve toward much more strongly **integrative** types of **organization**. Any system is a more or less highly organized reunion of associated **elements**.

0171

ASSOCIATOR¹⁾

"The **subsystem** which carries out the first stage of the **learning process**, forming enduring **associations** among items of **information** in the system"

This one of J. MILLER's 20 critical **subsystems** (1978, p.3)

0172

ASSOCIAZIONE ITALIANA per la RICERCA sui SISTEMI (AIRS)

→ Italian Association for Research on Systems

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

0173

ASSUMPTIONAL ANALYSIS ²⁾ - 4)

A **methodology** to reveal hidden assumptions of **stakeholders** in a **group** or **organization** confronted with some difficult **situation**.

This **methodology**, proposed by I.I. MITROFF and H.A. LINSTONE, is described by them in their 1993 book. Their general view is that it is "far better to debate a question without necessarily settling it than to settle a question without debating it" (p.146) Indeed, this last way is the best recipe to obtain an incomplete or false view of a **situation** or **problem**.

However, questions are settled without debate at least partly because their do not come out clearly and as a result, are easily ignored or jumbled. To make them appear clearly is specially important when they include conflicting views as held by the different **stakeholders**, because this is the only way to obtain a critical evaluation of the whole matter under consideration.

According to MITROFF and LINSTONE, the first step is to find out who are the **stakeholders**, that can affect or be affected by the **situation** as it is or as is could evolve. This they do by establishing a **graph** of all **stakeholders** (p.141). For example, in the case of a drug company, these are: the customers and patients; the physicians; the pharmacists; the suppliers; the salesmen; the competitors; government agencies; the holding company; the company management and the stockholders (not to be confused with the much more general **class** of the **stakeholders**!). In this way, it will become possible to obtain a most complete view of the **situation**.

The second step is to make the different **groups** of **stakeholders** expose their assumptions, which are mapped one by one into grids whose coordinates are "certainty-uncertainty" and "least to most important" (p.144)

In this way most hidden aspects can be brought to light and seriously debated. J. WARFIELD's **Generic Design** provides quite similar **methods** to avoid **underconceptualization** and incoherent debate (1994b).

Anyhow, assumptional analysis is by nature an open **process**. M. JACKSON considers that even after a synthetic list of assumptions has been established and a rating chart constructed (see hereafter), this is still a mere compromise among different- and possibly divergent- opinions. Thus "assumptions (should) continue to be negotiated and modified...for as long as progress is being made" (p. 228, 2000)

It is moreover obvious that the **issue** or **situation** may evolve. Accordingly assumptions may never be definitive, and corrective **iterations** of the analysis may be needed.

0174

ASSUMPTIONS RATING CHART ²⁾4)

After due and as complete as possible tracking of the respective assumptions of all **stakeholders** about some **issue** they should be evaluated, ordered, and rated according to their relative certainty and importance.

This is best done by constructing a chart with two perpendicular axes; the one from most to least certain, and the other from most to least important (M. JACKSON, p. 228, 2000)

The known Eisenhower graph on respective importance and urgency of issues- as well constructed along two axes- is also about assumptions ratings

0175

ASYMMETRICAL DEPENDENCE ²⁾

The dependence of systems on a lower **level** of **complexity** in relation to higher **level** ones in **organizations** or **ecosystems**.

This is a characteristic **relation** in **hierarchic systems**, where lower **levels** of **organization** depend on **regulations** and **controls** by higher **levels**.

More generally, any system or **subsystem** finds itself within a relation of asymmetrical dependence in relation to its **environment** or **suprasystem**. Even if and when it is able to modify its **environment** in a way more suitable to its necessities, such possibilities are limited by its **archetypical survival** needs.

It should be noted however that higher **levels** are also dependent of the lower ones, which provides them with the basic **inputs** they need in order to exert their **roles** as **regulators**, **controllers** and **deciders**.

0176

ASYMMETRY ¹⁾ - 2)

1) "The differentiation of one half from the other" (G. BATESON, 1973, p.353)

2) "A union of unequal opposites, the coexistence of two different, opposite poles in a unity" (H. SABELLI & L. CARLSON-SABELLI - 1992, p.660).

The SABELLI's view asymmetry, the general result of **symmetry-breaking**, as the fundamental cosmic order in relation to the temporal **flow** of **energy**, as "Whereas mechanics (classical, statistical, relativistic, or quantum) postulates stationary and **reversible processes**, **thermodynamics** and **dynamics** postulate that **processes** asymmetrically tend to **attractors**" (p.661). Thus asymmetry is "imprinted in the **form** of every **object**" (Ibid.).

H. SABELLI observes that "this concept of cosmic asymmetry has been validated in our century, beginning with the discovery of the non-conservation of parity in beta decay, the optical rotation of atoms, the string theory of **matter**, the importance of highly asymmetric, **nonequilibrium states** in the **thermodynam-**

ics of **open processes**, the asymmetric preponderance of **matter** over anti-matter, the **time** asymmetric **collapse** of the wave function in quantum mechanics, the asymmetry of crystals of which rocks are made, the violation of gauge symmetry by superfluids, the lack of symmetry in magnets and fundamental biological asymmetries... Asymmetric **structures** lead to asymmetric **processes**, and in turn the asymmetry of **processes** becomes imprinted as **structural** asymmetry" (1991, 219-20)

G. BATESON writes about the step from bilateral **symmetry** to asymmetry (in living beings): "... either the asymmetry must be achieved by a **random process** or it must be achieved by **information** received from the outside" (p.373).

In both cases, **positional value** of the receiving **element** becomes very significant.

Asymmetry acts as a factor of **organization** and **complexification** because it corresponds to **distinctions**, leads to **complementarities** and opens more possibilities for **differentiation**.

This had already been recognized in the 19th. century by L. PASTEUR and well explained in 1942 by Ch. LAVILLE, who constructed a theory of **fields** asymmetry.

Contemporary ecologists, as R. MARGALEF for instance (1982), also admit that asymmetric exchange between **living systems** (as in **commensalism** and **symbiosis**) leads to an increase of their global **complexity**.

M. HAAS established a typology of asymmetries. (1967). He distinguished:

temporal - spatial - kinetic - entropic and allocational asymmetries.

Within the temporal asymmetries he signaled (among others, which seem less significant): - **fluctuations** - **tides** - **discontinuities**

Within spatial asymmetries he mentions (also among others, more specific of social and political situations): - **segregation** - **centralization**

His description of kinetic asymmetries seems too restricted to these same social and political situations. It makes sense however to distinguish, for instance: - mobility at different **rates** - immobility

As to kinetic asymmetries, they seem quite basically related to different **levels** of **entropy** production in different **parts** of a system.

As to allocational asymmetries, HAAS' **classification**, as related to socio-political systems is difficult to transfer to other types of systems because it implies **values** of different kinds.

→ **Trend (Asymptotic)**

0177

ASYNCHRONISM ²⁾

The existence of different **rates** of **propagation** of some **change**, or its **effects**, in **space-time**.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

Asynchronism is closely related to **anisotropy**.

It can be observed within a system, or in the **environment** at large. It seems to be closely related to **chaotic behavior**, because of the growing interferences in **time** between the different sequences of **propagation**.

0178

ATTENUATION ²⁾

The decrease in a **feedback cycle** resulting of a negative **amplification cycle**.

Attenuation corresponds to the progressive **damping** of the concerned **process** or **function**. When persisting, it may lead to their disappearance, by total loss of any capacity for regulating **fluctuations**.

(For the opposite, see "gain")

0179

ATTRACTOR ^{1) - 2)}

A limited **region** of the **phase space** (i.e. a point, or a **set** of points) towards which the **trajectory** of the system converges, tending to a **steady state** or **periodic motion**.

This is the concept of attractor according to classical **dynamics**.

There are two basic types of classical attractors (as opposed to strange, or **chaotic**, ones):

1.-The attractor may be a single point (or **state**) towards which the system's **trajectory** converges in a monotonic way. This implies, for example, a tendency to **asymptotic stability**. This was the original mathematical **meaning** of the term.

2.- The attractor may be "a closed **loop**, corresponding to **periodic motion**" (I. STEWART - 1989, p.45)

This is a characteristic of systems which undergo a **cyclical** or **cyclomorphical activity**.

The first case corresponds to any system strictly submitted to the **2nd. principle of thermodynamics**, i.e. whose **entropy** grows steadily or, more precisely, to which a **trajectory** and the corresponding **energy function** is associated, such as its **value** constantly decreases with **time**.

The second case corresponds to systems which retain **dynamic stability** by maintaining their internal **structures** and **functions** within closely defined **limits**. Such systems tend to produce the minimum **flow of entropy** compatible with their absorption of **energy** obtained from the **environment** (cfr. PRIGOGINE's **irreversible systems** with small **fluctuations** as opposed to other **irreversible systems**, which undergo giant **fluctuations** throwing them out of their **stability limits**; and also his principle of **minimum entropy production**).

Attractors are **sinks**, which means that the attracted system is submitted to characteristic **constraints**, from which, in principle, it cannot escape using its own means.

In **chaotic dynamics** the motion becomes **quasi periodic** ("The geometrical picture for quasi **periodic motion** in quasi **space** is a curve that combines two or more different "circular" motions") (L. STEELS, 1990, p.45)

Hence, a **variety** of more and more complex attractors, which correspond to "the qualitative **diversity of dissipative systems**" (I. PRIGOGINE and I. STENGERS, 1992, p.69)

R. SWENSON characterizes the attractor as "The **time-independent (time-asymptotic) state**, or **limit set**, that attract **initial conditions** from some **region** around its "**basin of attraction**", during a **set of time-dependent processes (evolutionary behavior)** as t_y , "(after D. RUELLE, 1981) (SWENSON, 1989, p.189)

The **concept** of attractor is thus connected with the idea of dynamic **irreversible change**.

However, there seems to be two different kinds of these:

- **Adaptive change** in systems endowed with **organizational closure**, which cannot escape the necessity to reach a final destructive stable **state** ("Death is equifinal" says Stafford BEER)

- **Innovative change by emergence**. "Evolutionary **behavior**" corresponds to this kind of **transformations** (see "**attractor (emergent)**").

Francis HEYLIGHEN defines the attractor as "a region of **state space** invariant under the **dynamics** (each **state** in the attractor is sent upon a **state** of the same attractor) (1990, p.496), such that it does not contain subattractors. This means that there are no **fixed points** inside the attractor. Each point in the attractor is sent on another point of the attractor. This accounts for a **model** in which there is both conservation of the **distinctions** between different attractors and variation within each attractor". (Ibid).

Attractors may become multidimensional. M. FARGE defines the attractor's dimension as: "the **set** of the points of the **phases space**, i.e. of all possible positions and velocities that can be visited by the system, containing the set of all solutions within the **limits** of a very long **evolution in time**" (1992, p.214)

While any attractor controls a **basin** or area that converges to it, this area can be very narrow. In such a case quite small **disturbances** may push the system out of the **basin** and force it to **convergence** toward another attractor. These jumps from one attractor to another, very far to be a purely abstract **model**, are the gist of many **collapses** affecting real **structures**.

0180

ATTRACTOR (Chaotic) ^{1) - 2)}

Also called "strange attractors"

D. BROOMHEAD describes the chaotic attractor in these terms: "(It)... can be thought of as a bag in the abstract **phase space** defined by the **variables** of position and momentum; the bag contains an infinite number of **periodic states**, all of which are unstable. 'Unstable' in this sense means that if, at some **time**, the **behavior** of the system can be approximated by one of the **periodic states**, the approximation error grows exponentially with **time**. The interesting thing - and the resolution of the chaotic paradox - is that the bag, *as a whole*, is stable. Once the system is in the 'bag', it cannot leave; rather it wanders, moving close to one **periodic state** as it diverges from another" (1990, p.23)

It is thus quite clear that **randomness** in **chaotic systems** is *confined* within a global **determinism**.

I. PRIGOGINE and I. STENGERS observe: "Chaotic attractors are not characterized by whole **dimensions**, as a line or a surface, but by **fractionary dimensions**. They are what is called, since MANDELBROT, **fractal varieties**" (1992, p.73) (see: "**Fractal dimensions**")

J. CASTI makes this clearer as follows: "(in classical attractors) regardless of the **dimension** of the overall **state space**, the **fixed point** has **dimension 0**, while the **limit cycle**, being a simple closed curve, has **dimension 1** These numbers are the *geometric dimension* of the attractor. At the other end of the scale is the situation in which the system is truly **random**. In this case, every point of the **state space** is eventually visited, leading to the attractor's having the same **dimension** as the **state space** itself. **Chaotic systems** with their strange attractors lie somewhere in between. For such systems, the attractor is clearly not such a primitive geometrical object as a point or a simple curve. Yet it is still a proper **subset** of the overall **set of states**" (1994, p.101) (and, consequently has a fractionary, or **fractal dimension**)

0181

ATTRACTOR (Dynamic) ^{1) - 2)}

A stable **states cycle** in a **network**.

ST. KAUFFMAN, who applies this **model** to biological systems, states: "... once a **network's trajectory** carries it onto a **state cycle**, it stays there. The **set of states** that flow into a **cycle** or that lie on it constitutes the **basin of attraction** of the **state cycle**. Every **network** must have at least one **state cycle**; it may have more" (1991, p.66)

0182

ATTRACTOR (Emergent) ^{1) - 2)}

An **attractor** characterized by a progressive drive away from **equilibrium** (1989, p.189).

R. SWENSON states that emergent attractors result from interacting **processes** – that eventually **bifurcate** – and are more complex than the **processes** that formed them (Ibid)

S.J. GAO and F.J. CHARLWOOD distinguish four fundamental types of emergent attractors: **Fixed point** attractor, **periodic** attractor, **quasi-periodic** attractor and **chaotic** attractor. They state: "... they represent qualitatively different **states** of the system in different **environments**. The adapting and evolving **behavior** of the system can be defined as the quantitative **change** (changes of position in the **state space**) and qualitative **change** (changes of type) of these emergent attractors" (1993, p.62)

As examples of emergent attractors R. SWENSON cites: non **equilibrium** points, **limit cycles** and **chaotic attractors**.

He opposes the emergent attractors to **equilibrium attractors** or points, "by definition characterized by a drive towards it".

The emergent attractor is thus equivalent to a **dispersion** or radiating center, i.e. a **negative** attractor that we could call a "repulsor".

According to SWENSON: "Emergent attractors are **non-linearities**, and **nonlinearities** are emergent attractors. The spontaneous **transformation** of a **set** of atomisms (i.e. **elements** or **components**) from an infinitesimal **fluctuation** to a globally coherent dynamical **limit set** of **macroscopic scale** is, by definition, a **nonlinear**, viz **self-amplifying process**; the effects of the **attractor** (drive away from **equilibrium**) become its causes (the further away it goes, the faster it drives) until some **limit** is reached.

"When the **nonlinear relation** ceases to exist, so too does the "object" (**flow structure**), and its global **space-time correlation** vanishes into incoherence". (1989, p.189)

0183

ATTRACTOR (Fractal) ²⁾

A discontinuous attractor which governs the **behavior** of a **complex system**

An attractor is said to be fractal if the **fractal dimension** is not an integer.

This subject is discussed under the headings: "**Basin of attraction**" and "**Fractal basin boundaries**"

0184

ATTRACTOR (Quasi periodic)

→ **Attractor (Toric)**

0185

ATTRACTOR (Stability of an) ²⁾

Capacity of an attractor to resist **perturbations**.

As stated By St. KAUFFMAN: "Attractors tend strongly to exhibit **homeostatic** return after **perturbation**" (1993, p.209). However "The **stability** of an attractor is proportional to its **basin size**, which is the number of **states** on **trajectories** that drain into the attractor. Big attractors are stable to many **perturbations**, and small ones are generally unstable" (1991, p.67)

This explains the **instability** in **chaotic systems**, where frequent jumps occur between smaller and smaller attractors that appear through **fractalizing bifurcations**.

For the concept of "basin size" see "**Basin of attraction**"

0186

ATTRACTOR (Thematic)

→ **Thematic attractor**

0187

ATTRACTOR (Toric) ²⁾

An attractor which "... describes motion made up of two independent **oscillations**" (J. CRUTCHFIELD et al., 1989, p.42)

Such a motion is "sometimes called **quasi-periodic**" (Ibid)

J. CRUTCHFIELD et al. point out that : " The important feature of **quasi-periodic motion** is that in spite of its **complexity** it is predictable. Even though the orbit may never exactly repeat, *if the frequencies that make up the motion have no common divisor*, the motion remains regular. Orbits that start on the **torus** near one another remain near one another, and long term **predictability** is guaranteed." (Ibid).

→ **Numbers (Prime)**

0188

ATTRACTORS and BEHAVIOR MODES MODELING ²⁾

J. Aracil proposes an association of **attractors**, as **models** and **behavior modes**.

"It is well known that a **dynamical system** can show many **attractors**. With each **attractor** we associate a **behavior mode**. The attractors represent the **states** where the system is normally observed. The qualitative study of **dynamical systems** is concerned with the study of **attractors**. A very important question, that literature has not dealt with however, is to study how the variation of the theoretical framework along the **modeling process** can determine the possibility of **emergence** of new **behavior modes** (new attractors). This problem is linked to the **emergence** of **bifurcations** in the modeling **process** in the precise sense to be stated below. In this way the **modeling process** can be related to the concept of **structural stability** and with THOM's **catas-**

trophe theory paradigm considered in its widest sense, as a theory of **morphogenesis**: the **morphogenesis** of new **behavior modes** through the **modeling process**". (1986, p.244)

The lack of such a qualitative enquiry was one of the main shortcomings of FORRESTER's **Systems dynamics**

0189

ATTRACTORS; A classification ^{1) - 2)}

K.De GREENE proposes the following classification of attractors:

"1. Points, like the static **equilibrium** points of **catastrophe theory**. Points can apply to both **linear** and non-**linear** systems.

"2. Periodic attractors, like **limit cycles** that apply, say, to interacting **populations**

"3. **Strange**, **Lorenz** or **chaotic attractors**: A system **state** can be related to a **basin of attraction**, but how stable the system is and where the system resides relative to the **boundary** of the **basin** may be unknown and unknowable. Indeed, the very existence of an alternative **basin(s) of attraction** may be unknown". (1990, p.161)

Furthermore "...minuscule differences in **initial conditions** may lead to the exponential expansion of these differences" (Ibid.)

A slightly different classification is possible: **Fixed point**: The simplest attractor. It corresponds to a generally monotonous **trajectory** of a non disturbed system toward a final **state**, for example: a real pendulum, submitted to frictions.

→ ("**Fixed point**")

Limit cycle: Corresponds to a closed **loop** within the **phases space**. This implies that the system's **trajectory** involves a series of non-disturbed **periodic oscillations**.

Toric attractor: Characterizes the **behavior** of a system simultaneously submitted to two periodic **oscillations**, independent from each other. The **structure** of these **oscillations** remains always predictable and possible to carry out, even when the **periods** are incommensurable.

→ "**Numbers (Prime)**"

Chaotic attractor: Corresponds to the **behavior** of a system simultaneously submitted to, at least, three **periodic oscillations** independent from each others. The simplest corresponds to systems of simple differential equations where the **phases space** is three-dimensional.

Even in these cases the **transformations** of the system are generally not predictable. An early example was the famous astronomical **three bodies problem** studied by POINCARÉ.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0190

ATTRIBUTE¹⁾

Any quantitative or qualitative property of a system, **subsystem** or any of their **elements** (Adapted from J. van GIGCH, 1978, p. 14)

This author adds: "Qualitylike" attributes of greater difficulties of definition and of measuring than their counterpart – the "quantitylike" attributes" (Ibid)

0191

AURA¹⁾

The **set** of the traces or **constraints** left over by a system after the end of its functional existence.

This stimulating systemic concept has been introduced by the French biologist H. PRAT. It can be applied to a fossil, or petrified wood, as well as to a sunken ship, or a destroyed empire, or the teachings of a great disappeared mystic or philosopher. (1971, p. 92-5)

At any moment the system contains its history and, when it functionally ceases to exist, something may remain of it. In J. BRIGGS and F.D. PEAT's words "Time is inflexible, and however, the past is continuously recycled, somehow maintained eternally" (1991, p. 145).

The aura corresponds to a kind of fossil **field**, i.e. a certain degree of **survival** of material and/or abstract **structures**, given the condition that there be no excessive disruptive **environmental activity** and that important **interconnections** between **elements** remain more or less intact, or correlatively transformed.

In some cases, the aura may even give birth to a new system. A curious example is the "Gustav Vasa", flagship of the Swedish navy, sunk in the 16th Century, forgotten for 300 years, then refloated in the 20th Century, and now a naval museum in Stockholm's harbor.

G. CHROUST gives a complementary **meaning** to the concept, asking how far the **effects** of teaching do extend in **space** and **time** and also, "what **size** can a **group** have such that one can still communicate effectively" (1999, p. 419).

These aspects can be mapped by using **graphs** and are also related to the **small world model**.

0192

AUSTRIAN SOCIETY FOR CYBERNETIC STUDIES¹⁾

This Society is one of the oldest in Europe. Its original name in German is "Österreichische Studiengesellschaft für Kybernetik". It was created in Vienna by a group of Austrian cybernetists under the leadership of F. de PAUL HANIKA and Dr. R. TRAPPL, who is still its President.

It publishes technical reports, principally on A.I. and hosts the editorial office of the "Cybernetics and Systems" Journal, whose Editor-in-Chief is R. TRAPPL.

It organizes in Vienna every other year since 1972 a "European Meeting on Cybernetics and Systems", whose proceedings are published.

It has been one of the co-founders, with the **ISSS** and the **Systeem Groep Nederland** of the **International Federation for Systems Research**.

0193

AUTOCANALIZATION²⁾⁵⁾

A **process** of self regulated **evolution** in the **biosphere** as a **whole**.

This concept has been introduced by V.F. Levchenko and Ya.I. Starobogatov.

In a more recent paper, Levchenko writes: "...canalizing factors include the **environment** which is not invariable with **time** but depends just on the **evolution** of both the **biosphere** itself and the **organisms** it is composed of" (1998, p. 106)

Self-regulation in natural systems was also suggested by François (1983), himself inspired by Ashby's "Principles of the **self-organizing system**" (1968)

Autocanalization is certainly significant for the understanding of Lovelock's GAIA (1979)

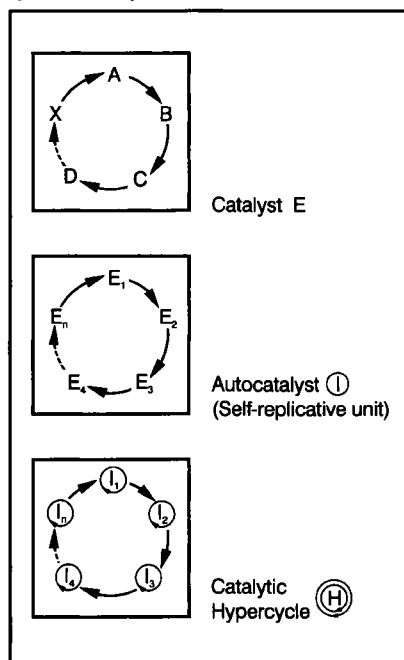
0194

AUTOCATALYSIS²⁾

A **process** in which the increase of an **element** in a system is enhanced by the concentration of the **element** itself.

The reaction's product is itself the **catalyzer**.

Figure: see entry **AUTOCATALYSIS**

**Autocatalysis**

From M. EIGEN and P. SCHUSTER: "The hypercycle" 1979 - p. 90

Autocatalysis is basically a **self-amplifying process**, but moved by a **cyclical positive feedback with relaxation phases**. It may however lead, in a limited **space**, either to a destructive supersaturation or, exceptionally to the **emergence** of a new **level of organization** of the **elements** reaching a **critical density**. K. KRIPPENDORFF observes that: "Autocatalysis is not to be confused with multiplication through **production**, including **self-reproduction** in which the **growth** of the **population** is an aggregate property of the productive capability of its individual members" (1986, p.5)

see figure left

0195

AUTOCORRELATION²⁾

"A statistical measure of the strength of association which exists between pairs of values of a **time series** as a **function** of the **time interval** which separates them". (T.F.H. ALLEN & T.B. STARR 1982, p. 262)

0196

AUTOGENESIS¹⁾

The appearance of a new system by association of formerly unconnected **elements**. (C. FRANÇOIS, 1989, p.72)

"In some sense, autogenesis appears as a absolute beginning. "Before" there was "nothing" (i.e. only scattered, unconnected **elements**); "after", we suddenly have a new system, immediately **morphogenetic** and **autopoietic**. The **event** is, partly, a **random** one. This is interestingly paralleled in John H. CONWAY's **game of life**, where it is the player who defines an **algorithm** for general genesis conditions whose potential content he ignores. He does not know in which way the system will develop, or if and when it could become blocked or destroyed. However, the original **random decision** remains inserted within the most general conditions of the game: **elements, rules, a field, limited or unlimited**".

"In this sense, however, autogenesis appears as a relative beginning" (Ibid).

"Before", there were significant antecedents: **elements** and an **environmental situation**. "After", we have some new entity born with and within these antecedents. What is new is the combination. However, it takes place within an **archetypal algorithm**, which represents a kind of **autopoiesis** at a higher **level** in **space-time**.

Some examples will make this clearer:

- The autogenesis of a complex and original living being⁵⁾.

Can result only from the sexual pairing of two previous systems of the same kind. What is autogenetic is the fusion of two half genomes, and more precisely of *these* two half

genomes, while trillions of other combinations were possible. This is quite akin to an irreversible **decision**, but in this case its significance, if any, remains undecipherable for us.

The **autopoietic** aspect is that each of these half genomes must be of the same species, in order to be able to construct a new viable **autopoietic system**. This means that, even considering that the new system is an original and unique creation, it remains within the **limits** of a more general **algorithmic** and combinatory **model**: in this case, the species. Future genetic manipulations could possibly modify this general frame.

- Neural autogenesis ⁵

According to V. CSANYI: "... in the course of **ontogenesis**, the human **brain** goes through phases of neural autogenesis, the phases of non-identical replication and identical **replication** and the **phenomena** of each phase (functional **differentiation**, rise of **hypercycles**, compartmentalization, **convergence**) can also be observed. The human **brain**, which consequently represents a **zero-system** capable of neural **evolution**, develops in the course of **embryogenesis**" (CSANYI, 1989, p.80)

- The autogenesis of a society ⁴:

The autogenesis of a society, as an **emergence** into a higher **level of complexity**, offers the same characteristics, but more general. A cultural example will be used, but others, biological, political or economical could be given.

A human society in its phase of autogenesis entails the progressive co-**assimilation** of various **heterogeneous** groups, bearing different cultural inheritances and coming for the first time in contact in some defined area (by invasion, immigration, colonization, etc.). In this case, the fusion **event** seems, at our **time-scale**, a slow and hazardous **process**. However, at the historic **time-scale**, it is really be a very short one.

What is leading to **autopoiesis** here is the common pre-existence of a **variety** of cultural traits. While different, they are all somehow related to the unavoidable **constraints** of societal **organization** in general, as any society needs in order to survive some specific **environmental** conditions, as well as basic **values** and **norms**, transmittable from one generation to the next. (FRANÇOIS, 1989, p.72-73)

→ **Autopoiesis; Epigenesis; Equipotentiality**

0197

AUTOGENESIS (From) to AUTOPOIESIS ²⁾

This transition results of the appearance of **replication** within hitherto not functionally interconnected **sets** of compatible **components** (CSANYI's "**zero-system**")

This author writes: "A system may contain several different kinds of **components**, which are all **replicative** units with diverse fidelity. Among these, **interrelationships** develop and, as a result, their **replication** becomes coordi-

nated. Gradually the **whole** system will start **replicating** as a final **replicative** unity. In the autogenetic **process**, the **organization** of the system and of its **parts** changes due to the **functions** of the emerging new **components**. Thus autogenesis is possible only while the **state** of identical **replication** has not yet been achieved. In that **state**, the system becomes functionally **closed** and its **replication** in **time** continues as long as the **environment** does not change. There are no further organizational **changes** initiated by organizational causes because new **functions** cannot originate... This end **state** of an autogenetic system is equivalent to what VARELA calls **autopoiesis**" (CSANYI, 1993, p.264)"

There are **time limits** to **autopoiesis**, because the capacity of any system to generate **accommodating** or **adaptive** responses to **environmental stimuli**, while considerable, is however limited: systems are maturing and finally **ageing**.

0198

AUTOGENETIC SYSTEM PRECURSOR (AGSP) ²⁾

A minimal **set** of **components** in a system in its initial **phase of autogenesis (zero-system)**, which has the potential to start producing **processes**. (After V CSANYI, 1993, p.263)

CSANYI explains: "A precondition for starting a **self-organizing process** in a **zero-system** is the presence of a minimal **set** of **components** which is able to replicate and which fulfills the following criteria:

"1. It contains at least one **cycle of component-producing processes**;

"2. At least one of the **components** participating in this **cycle** can be excited by the **energy flux** flowing through the system" (Ibid)

This **model** seems apt to cover autogenesis in future artificial systems as well as in actual **living systems**

It also explains the "jump" from autogenesis to **autopoiesis**, as Csanyi describes it: "During autogenesis, as **time** advances, an increasing part of functional **information** becomes **replicative information**. This can appear only as an extension of AGSP, that is, additional **replicative cycles** appear which are interconnected with the AGSP" (Ibid)

0199

AUTOGNOSIS ³⁾

The study of the conditions of conscious **knowledge** (Adapted from W. DILTHEY: Gesamtelte Schriften, 1922-1935)

This is a step forward from SOCRATES "Gnoti seauton". His membership of the Athenian **culture** of his time was implicit for him and at the same time subtly preforming his way of being and thinking.

Such cultural and historical conditions are proper to any individual **observer**.

Being this observer inserted in his specific culture at a precise historical moment, he thus acquires peculiar **reference frames** in some well defined psychical and mental **environment**.

This setting has been considered by Dilthey in his "Critique of speculative systems and nature explanation starting from **consciousness** facts and the historical march of world thinking" (Note: spanish translation used: the german original could not be located). Dilthey describes the result as "reality for myself".

Accordingly, autognosis is (or should be!) a permanent **process**, but at the same time subordinated to what has already been acquired by **learning** and training through former **experience**. It is a sort of sedimentation in an **autopoietic** way. Dilthey uses Goethe's term "Protophenomena". He also quotes BENCKE and says: "thought as such...analyses experience"...of course within the already acquired mental and conceptual frame.

Autognosis is closely related to modern hermeneutics, as proposed by Dilthey in his 1900 book on the "Origins of Hermeneutics"

0200

AUTOKINESIS ¹⁾

Capability for self-controlled (**autonomous**) movement.

This concept has been extensively elaborated by the French physiologist P. VENDRYES (1942)

It is exclusively proper to animals and up to a point to **artificial organisms** endowed with perceptive capabilities and **regulation** devices.

Throughout the scale of the animal reign, autokinesis grows with **complexity**. It will possibly be the same with intelligent **artificial organisms**.

Autokinesis would be impossible without **correlation** devices (senses, nervous system), empowering the system with possibilities to evaluate the **dynamics** of its displacement within its **environment**.

0201

AUTOMATA: A Classification ²⁾

According to M. BUNGE: "An automaton is a discrete and sequential system"

BUNGE distinguishes deterministic automata from probabilistic ones: "If lacking in spontaneity, i.e. acting only under external compulsion, the automaton is called **deterministic**. If **inputs** and internal **states** determine only **output** probabilities, the automaton is called **probabilistic**."

Deterministic automata are of interest mainly in technology, where highly reliable systems are desirable. Probabilistic automata are of greater scientific and philosophical interest, for

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

natural systems, such as **brains** and **communities**, are endowed with some spontaneity and seem to have strong stochastic **components**" (1979, p.263)

Some years after BUNGE wrote these lines, the development of the theory of **deterministic chaos** blurs somewhat the above **distinction**. But it also explains how an automaton, or system may function, being partly deterministic and partly stochastic.

G. KLIR proposed a different classification of automata, in accordance to their possible uses:

"1. Decoder-combinatorial automata which have the same **input** and **output variety** and in which the **mapping** between **stimuli** and **responses** is mutually unique.

"2. Prospective automata – combinatorial automata Prospective whose **output variety** is smaller than the **variety** at the **input**, and in which a single **response** is uniquely assigned to each **stimulus**, whereas the converse assignment is not unique.

"3. Retrospective automata – sequential or complex **random** automata, the **output variety** of which is larger than their **input variety** and where a single **stimulus** is assigned to each **response**.

"4. **Function** generators – sequential or complex automata which, as a result of at least one **stimulus**, produce in their **output** a **response** that is either a **determinate** or a **random function of time**.

"5. **Self-organizing** automata – sequential or complex automata, in which the **variety** of the **responses** produced by a given **stimulus** can change (as a **rule**, diminish) under certain circumstances." (1965, p.37)

This last class is very important as it corresponds to all natural and artificial **autopoietic** systems.

0202

AUTOMATA (Initial Configuration in cellular)^{2) - 5)}

A **set** of cells or **elements** arranged in some specific order which constitutes the initial **state** of the cellular automata.

Curiously, some initial **configurations** cannot be produced starting from any previous **configurations** (see **Garden of Eden**).

While some **configurations** can lead to **self-reproduction**, most cannot.

In some cases the **rules of transformation** of the cellular automata are embedded within its initial **configuration**.

0203

AUTOMATA NET²⁾

A finite **net** of interconnected **elements** which operate on basis of an on-off logic.

This is a very general **model** that has been used in genetics (St. KAUFFMAN, 1969), in **models** of the cerebral cortex (D. DUBOIS, 1991), in **connexion machines** (T. TOFFOLI & N. MARGULIS, 1987) and quite recently in distributed **artificial intelligence** (R. BROOKS (1989); C. LANGTON; L. STEELS, 1990)

Automata nets present characteristic **emergent** properties and **behaviors**, which depend on the nature of their **interconnections** or "wiring".

The **net** must have **constraints**, i.e. some **connections** being permitted and other ones suppressed. **Flows** through the **connections** can be permanent or more or less **intermittent**. Furthermore, such **nets** tend to subdivide into local and specialized **subnets** and, as a result, simultaneous **events** in different **parts** of the **net** do not propagate their **effects** instantaneously and generate very complex **nonlinear** (and sometimes **chaotic**) **behavior**.

Automata nets present very numerous alternative possible **steady states** and in some cases, undergo giant **fluctuations** that may lead to **bifurcations** and **dissipative structuration**.

Once the **set** of internal **states** can be specified through a finite **state transition matrix**, the automata net becomes a **finite automaton** or, if it produces **outputs**, can be assimilated to a **sequential machine**. This does not however make it wholly predictable.

0204

AUTOMATA (Reliability of)^{3) - 5)}

H. ATLAN states as follows the problem of comparative reliability of natural and artificial **machines**:

"A reliability like the one of the **brain**, able to function continuously, while **cells** die every day without replacement, with unforeseen **changes** in the blood's **flow**, volume and pressure **fluctuations**, not to mention amputation of important **parts**, which perturbs only in a very limited fashion the whole **set's performance**, is not matched in any artificial automata. This fact had already struck J.von NEUMANN (1966), who was seeking to better the computer's reliability and could not imagine such a reactive difference to **random environmental** factors of aggression (**noise**), if not related to a basic difference in the organizational logic of the system. "**Organisms**, with their faculty to "swallow" **noise**, could not be understood as just only somewhat more reliable than the known artificial **machines**, but as systems whose reliability could be explained only by qualitatively different principles of **organization**" (1972, p.23)

"VON NEUMANN, WINOGRAD and COWAN's (COWAN, 1965) investigations aiming at the discovery of construction principles for automata whose reliability would be greater than their **components**'...led to the definition of nec-

essary (and sufficient) conditions of feasibility of such automata). Most of these conditions, (**redundancy** of **components**, **redundancy** of **functions**, **complexity** of **components**, delocalization of **functions**) lead to a kind of compromise between **determinism** and **indeterminism** in the build up of the automata, as if some measure of **indeterminacy** should be necessary, from a certain **level** of **complexity** on, to allow the system to adapt itself to a certain **level** of **noise**" (ATLAN, 1972, p.23).

0205

AUTOMATA (Rules of transformation in cellular)^{2) - 5)}

Those **rules** which prescribe the ways in which the **elements** of the automata will be created, maintained or destroyed at each **transition** from one to another **state**.

Different rules are possible, leading to:

- a seemingly **random transformation**
- **self-reproduction**
- blocage in some definitive **state**
- some **cyclical transformation** of the automata

→ **Game of Life**

0206

AUTOMATA (Self-reproducing)^{3) - 5)}

In L. LÖFGREN words: "... an automaton where the **behavior function** *F* is considered self-reproducing if, from some **stimulus**, it produces another automaton with the same **function** *F*. This leads to the question whether a **function** can contain itself in its **range**" (1978, p.247)

In view of **GÖDEL'S incompleteness theorem**, this does not seem to be a very promising proposition.

However ATLAN states: "...up to now the only self-reproducing automata known are the natural **machines**, i.e. the living **organisms**" (1972, p.22). But even this view should be qualified: reproduction by division is not the same **process** as sexual reproduction. Besides, self-reproduction has now a specific **autopoietic** meaning.

ATLAN also writes:

"a) Living **organisms**' specificity is related to (cybernetic) principles of **organization**, and not anymore to irreducible vital principles

"b) Once these principles are outlined, nothing should impede their application to artificial automata, whose performance could equalize those of living **organisms**" (p.22-23)

0207

AUTOMATA (Self-reproductive cellular)^{2) - 5)}

An automata able to reproduce itself, i.e. to produce a copy of itself after a number of **transformations**.

The project of a self-reproducing cellular automata was initially formed by J.von NEUMANN.

Self-reproduction in a cellular automata is clearly different from **self-reproduction** in the **autopoietic** sense, whose **models** were established later. However, both are obviously related

It is debatable if the appearance of a "copy" of the initial automata in some other **region** of the **substrate** is equivalent to the **endogenous self-reproduction** of a system endowed with **organizational closure**.

H. Maturana states: "Cells do not construct other cells, they just divide into two of the same kind, like in the fragmentation of a crystal" (1979, p.25)

A von NEUMANN automaton would be self-reproducing as a whole in a limited sense only if, after a number of **operations** (through a **process** akin to an **hypercycle**), it would regenerate *itself*. The automaton would then comprise the whole cycle.

Otherwise self-reproduction would mean production of another automata of the same type, and eventually of many other ones.

It is however possibly a matter of **levels**. **Self-reproduction** of the **elements** (in the sense of cellular automata) could conceivably lead to the **self-reproduction** of the **complex system** (in the sense of **autopoiesis**)

P. GREUSSAY comments: "von NEUMANN thought that, with a convenient **programming** of some cellular surface, some group of **cells** with proper characteristics would be able ...to produce a copy of itself in another zone of the cellular surface, this copy being able in turn to do the same" (1988, p.1321)

To achieve his goal, von NEUMANN selected a complex **repertory** of 29 possible **states** combined with an intricate **transition function**.

"In 1968 Edgar CODD... discovered a universal constructor **configuration** whose cells are limited to 8 different **states**.

"In 1984 Christopher LANGTON (University of Michigan)...showed that a self-reproductive cellular automata does not necessarily need the intervention of a **cell configuration** endowed with the property of a **universal constructor**" (Ibid, p.1322).

In von NEUMANN, CODD and LANGTON's cellular automata "the **self-reproduction process** is actively directed by the **initial configuration** itself, through a **transition function**. Take an **initial configuration** at random and there is no more any **self-reproduction**. Thus such a **self-reproduction mechanism** requires a quite complex and substantially precise construction. Indeed, to endow the parent **structure** with the capacity to actively direct its own duplication, transcription devices of the "genet-

ic material" of the **initial configuration** are needed, as well as **translation** devices acting on the **environmental** cellular surface" (p.1322)

We are coming thus very close to **organizational closure** in **autopoiesis**.

This research promises to be highly significant for the logic of future complex computers and probably also for genetics.

0208

AUTOMATION⁵⁾

The use in **production** and in **control processes** of **machines** having the capacity to adjust to changing conditions

"The **adjustments** require "sense **receptors**" (which take readings from the **environment**), **communication networks**, stored **memory** of standard **states**, correction devices, etc. All of these make for greater **complexity**, since the **state** of each device is an additional **variable** in the **state** of the system" (A. RAPOPORT, 1966)

Automated **machines** tend thus to become **open systems**, more **autonomous** and more similar to **living systems**.

They are normally **integrated** within still more **complex systems**.

0209

AUTOMATON (Cellular)²⁾

1. An abstract device able to transform itself.

The **concept** of a cellular automaton has been developed by A. TURING (1950) and John von NEUMANN (1956) and also somehow by W. McCulloch and W. Pitts (Their **formal neuron model**)

F. HEYLIGHEN describes cellular automata as "... mathematical **models** of **distributed** dynamical **processes** characterized by a **discrete space** and **time**" (F. HEYLIGHEN, 1997, p.33)

The conditions for the construction of a cellular automaton are as follows:

- an unlimited and uniform **substrate**, which constitutes a perfectly **isotropic environment**
- identical **elements** or cells, with defined properties
- an **initial configuration**, consisting of a number of **cells**
- definite **rules of transformation**

The basic characteristic of cellular automata is the **emergence** of complex **organization** obtained from simple **rules**.

Numerous varieties of cellular automata have been proposed. The best known are those in CONWAY's **Game of Life**. However MARUYAMA has used one as early as 1963 as an example of "**deviation-amplifying mutual causal processes**".

As to the **rules of transformation**, some are not deductible from any previous **configuration** ("**Garden of Eden**")

In some cases the **rules of transformation** are themselves embedded within the **initial configuration**.

2. A **network** composed of **elements (nodes)**, each of whom is an elemental device able to perform some elemental calculation.

Every **element** of the cellular automaton may be considered itself an automaton if its **operation rules** are included. According to A.G. BAR-TO: "Cellular automata are **networks** of identical automata which are interconnected in a regular way with the automata having neighboring positions in the **network**" (1978, p.165)

B.R. GAINES and L.J. KOHOUT state: "...an automaton is a **discrete-time, discrete-state-space, state-determined machine**" (1976, p.192).

Each **element** processes a limited number of possible **binary states**.

The automaton evolves step by step, in a **discontinuous** way, according to the **rules** imposed to its **elements**, which determine at each step the **state** of each **node** according to its preceeding **state** and the **states** of the neighbouring **nodes**.

Curiously, a very complex global **behavior** may emerge from the application of quite simple **rules** at local level.

GAINES and KOHOUT state: "... neither the actual current **state** of an automaton nor its current **input** are necessarily well-defined. For example, we may know only the *probability distribution* of possible current **states**, or of possible current **inputs**. In either case the next **state** of the automaton will not be necessarily a single **state** but will probably also be known only as a **distribution**" (Ibid)

ASHBY has given interesting examples of such **ergodic systems**, whose **repertory** of all possible **states** is resumed in a **markovian matrix**. (1956)

According to GAINES and KOHOUT: "It is a convenient generalization of the **concept** of an automaton to consider **transitions** not just between **states** but between such **states distributions**, regarding **distributions** over **states** and **inputs** as generalized "states" and "inputs" respectively" (Ibid).

These authors propose the corresponding terminology of **hyperstates** and **hyperinputs**.

The automaton model is nowadays basic to the study of so-called **neural networks**, **connection machines** and **distributed artificial intelligence**.

It may even become very useful for the **description** of **social systems** in general.

0210

AUTOMATON (Finite)²⁾

A finite automaton is characterized by the following properties:

- an **initial state**
- a finite **set** of possible internal **states**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- a next-state **function** allowing for **transitions** from one internal **state** some other one
- a **subset** of the **set** of internal **states**, whose elements are **selectors of inputs** (accepting states)

An elemental automaton is open to any acceptable **input** and must necessarily function as a **sequential machine**. It can be represented by a **graph**. (After F. HARARY and S. LIP-SCHUTZ, 1967)

However, according to J.von NEUMANN, as quoted by L. LÖFGREN: "... when an automaton is not very complicated, the **description** of the **functions** of that automaton is simpler than a **description** on the automaton itself but ... the situation is reversed with respect to complicated automata" (1977, p.211)

This is a result of the **simultaneous** interplay of various **rules**, which leads to **ergodicity** or **chaos**.

0211

AUTOMATON (Learning)¹⁾⁵⁾

A type of automaton made of several **subroutines** able to interact

An interesting example is R.A. Brooks's "Allen" robot, described as follows by M. Pesche (2000): "Allen does not "think" about the room it occupies: it makes no effort to build a **model** of the room it occupies: or to understand the shapes of the objects inside"(p. 29)

"Allen is thus not programmed, i.e. no precise prescriptive instructions guide its **behavior**. It does not respond to the general characteristics of so-called "Artificial intelligence". Pesche writes: "Allen is built with a tight **connection** between its **sensors**, which detect the presence of nearby **objects**, and its effectors, which move the **machine**..."

"...Allen does not follow a **routine** sequence of **programming** steps to generate its moves. Several modular **subroutines** - such as drives to avoid moving objects and to explore uncharted **territories** run simultaneously and independently, which causes them to interact in unpredictable ways as they respond to the **environment**.

"Neither of these independent **modules** begin operating with any **knowledge** about their **environment**, nor about how their **activity** affects this **environment**. But as the **modules** execute, they compete to generate some aspect of Allen's overall **response** to its **environment**"(Ibid)

This is quite similar to Rumelhart and McClelland **Parallel Distributed Processing** and it leads to a **bottom up** construction of a globally **coherent behavior**.

Interestingly, Pesche observes the similarity of Allen's **behavior** - as an automaton - with **learning** in children as was investigated by Jean Piaget, who described children's play as "...an advanced experiment in the ways the world works"(p. 30)

Both ways of learning lead to behavioral **autopoiesis**

0212

AUTONOMY^{1) - 3) - 4)}

The capacity of a system to select and decide, within **limits**, its own **behavior**.

This concept of autonomy was introduced by the French biologist P. VENDRYES (1942). It is quite different from MATURANA and VARELA's concept, introduced about 20 years later, but in no way incompatible. VENDRYES described a **hierarchy** of various **levels** of autonomy: trophic (or **metabolic**), kinetic (motor) and psychic and mental. This corresponds more or less with LABORIT's **hierarchic** concept of the **brain's organization**.(1954 and 1976). This concept of autonomy is essentially based on the relative possibility of the system to **control** its **relations** with its **environment**. It also implies a specific **concept of time**: present **time** is the **connection** between an already strictly determined past and a still more or less probabilistic future offering yet possibilities to select between various **choices**. Such **selection** converts one - and only one - of these options into reality, suppressing all the others. This **concept** thus implies a **limited** probabilistic view of the future, quite consonant with the more recent concept of **chaos**.

In the same vein, K. BERRIEN observed "1) **Choice** is the human equivalent of probabilistic **outputs** in the more general **systems theory**" and "2) Although some of the determining **parameters** (can be specified), their precise **measurement** is subject in principle to an **uncertainty** of the same general kind as originally indicated by HEISENBERG" (1968, p.97)

VENDRYES theory describes as follows the **goals**, **means** and **mechanisms** that characterize autonomous systems:

- **Counter-randomness**: The system uses regulating devices to compatibilize **random inputs** with its internal **determinism**;
- Internal **determinism**: The system is able to maintain the **fluctuations** of its internal **processes** within stable **limits**. This connects VENDRYES' views with CANNON's **homeostasis** and with MATURANA's **autopoiesis**;

- **Interrelation functions**: The system possesses mediating **functions** that coordinates its internal **states** with the **environmental** variations;

- Internal **medium** ("**invironment**"): This is the internal **space** of the system, where the **interrelations** between the **subsystems** take place. This concept comes from Cl. BERNARD and connects VENDRYES autonomy with J. MILLER's **living systems**, and again with CANNON's **homeostasis**, also inspired from Cl. BERNARD.

- **Perturbation**: Any **input** not yet controlled by the system. However, many **inputs** are needed by the system, and their **assimilation** is an essential aspect of the system's **symbiosis** with its **environment**.

- **Random relation**: Any not pre-defined **interrelation** of the system's **inputs** with its internal **states**. VENDRYES explains that the **relations** between two systems are **deterministic** when already functionally linked and **random** when not linked. The system may gain - up to a point and with **time** - predefined **controls** on critical **inputs**. This is another link with **autopoiesis**.

- **Articular relation**: A **mechanism** which permits the **selection** at any moment of a position, **state** or motion among various that are possible. The **model of articular relation** has been widely developed by VENDRYES. (see specific heading)

- **Reserve**: A potentially usable **store of energy** or **matter** within the system, that can be used at any moment by the corresponding **control** to offset in real **time** or within a **time lag**, a specific **perturbation**. This is a need in order to maintain the system distinct from its **environment**. **Controls** are efficient only if associated with specific **reserves**. (see specific heading)

Another viewpoint is given according to a subtle definition by R.H. HOWE: "Autonomy is the unity of computation and construction" (1975, p.5)

In this case, computation should be understood as that type of computation which occurs in concrete **neural networks** (i.e. any system with internal **communication** between numerous **elements** in an **organizational closure** way), and construction as **self-reproduction**.

In the last resort, it must however be emphasized that a system's autonomy depends always of its possibility to obtain sufficient **energy inputs** from its **environment**. In A.S. IBERALL words "... an autonomous system is a thermodynamic engine" (1973, p.4)

This basic condition, the existence of an **organizationally closed set of rules** being also provided for, allows for the autonomous existence of the system.

Still more generally, more autonomy also means more **interdependence** among more **components** and **subsystems** within the system and more extended and complex relations with a more precisely specified **environment**. Man for example, needs many more specific types of **inputs** than a tree.

0213

AUTONOMY BY AUTOPOIESIS^{1) - 3)}

"Attribute of an **organizationally closed system**, i.e. a system whose **organization** is self-explanatory and, by implication, circular" (K. KRIPPENDORFF, 1986, p.5)

Autonomy in MATURANA and VARELA's sense is self-generated through an **organizational closure process**. In R.N. ADAMS words: "...control over relations of production is wholly internal" (1988, p.63).

This is a property of **living systems**. H.von FOERSTER writes: "By autonomy we mean that all **decisions** regarding an **organism's action** are made within its skin. A living **organism** is a **universe** in itself". von FOERSTER proceeds, giving the following example:

"1. The **interpretations** of an **organism's** sensations determine its **activity**;

"2. An **organism's activity** determines the interpretations of its sensations" (1981, p.215)

He resumed his stand in these terms: "A living **organism** is an independent, autonomous and **organizationally closed** being" (1992, p. 42). By "independent" (in the German text "selbständig", i.e. "existing by itself"), one should understand "**entficated**" in R. GERARD sense.

von FOERSTER also stated that autonomy is "**self-regulation**" or "**regulation of regulation**" (1981, p.306), which locates him quite close to VENDRYES.

P. GÓMEZ and G.J.B. PROBST, in turn, write:

"1. The development and **viability** of a system depend much more on internal **coherences** than on **environmental inputs**. What is important is what the system does, how it acts, and finally, how it reacts to **noise** from the **environment**

"2. An autonomous system produces its **limits** and the **limits** define the system. Research should emphasize the search for **sources** and **rules** of the internal **transformations** of **coherences**" (1989, p.314)

The first statement could be somewhat misleading. No system can emerge, develop and maintain itself if the necessary **inputs** are not available in the **environment**. Only the *pre-adapted* systems are viable. Of course, **pre-adaptation** is a result of **autopoietic transmission** of formerly **emerged** conditions. As an example, an astronaut is viable in space only if the basic **environment** he/she imperatively needs for **survival** is artificially recreated and maintained.

Autonomy itself is obtained only within the specifications of an inherited or formerly **emerged template**.

→ **Archetype**

0214

AUTONOMY: the 3 basic levels ¹⁾

J. LORIGNY writes: "According to P. VENDRYES three levels of autonomy should be distinguished: metabolic autonomy, motor autonomy and mental autonomy...

"VENDRYES's three autonomies correspond to three successive stages in **evolution**. Each developed at a definite stage of life's history and does not emerge formerly, at least in a visible fashion... The more recent ones are imbricated into the former ones, each using them after incorporating them...

"Thus, **motor** autonomy uses **metabolic** autonomy... and in the same way, mental autonomy uses **motor** autonomy... (Furthermore) each autonomy feeds and reinforces the former ones, having them **embedded** in a systemic **hierarchy**" (1992, p.13).

Strikingly enough, when compared with MATURANA and VARELA's concept of **autonomy** and **organizational closure**, VENDRYES himself wrote as early as 1942: "The living being is to itself its own **reference system**" (1942, p.290).

0215

AUTOPOIESIS ^{1) - 2)}

The condition of a system able to regenerate itself by **self-reproduction** of its own **elements** and of the **network** of their characteristic interactions.

This notion has been introduced by H. MATURANA, who writes: "... there are systems that are defined as unities as **networks** of production of **components** that 1) **recursively**, through their **interactions**, generate and realize the **network** that produces them; and 2) constitute, in the **space** in which they exist, the **boundaries** of this **network** as **components** that participate in the realization of the **network**" (1981, p.21).

The main characteristic of autopoietic systems is **organizational closure**.

Autopoiesis has very important bearings on the theories of **perception** and of **cognition**. As stated by W.R. WINBURN: "The perspective of autopoiesis, in which **organisms** are described "from the inside out", proposes a basic shift in the **observer-object relationship** behind traditional scientific **observation**. **Living systems** are explained only by **reference** to features within the possible **domain of interactions** specified by their **organization**" (1991, p.565).

One wonders however what WINBURN really means when he writes: "But autopoiesis defines biological **autonomy** in terms of **self-referential organization** of **living systems**. From this vantage point, **organisms** are necessarily **input-less** and **closed**" (Ibid). This seems to be unfortunate semantics (more than once to be found in autopoietic literature): any **living system** depends on **inputs**, a lot of them. That these **inputs** be assimilated by **organisms** in a way non-contradictory to their internal **self-referential organization** is a different point, related to that kind of systemic stabilized **identity** obtained through autopoiesis.

R. ROSEN's formulation seems better: "... a non-empty **environment** can only affect **autonomous system behavior**, never its **autonomous dynamics** or **identity**" (1993, p.27). Even so, any system can be destroyed by its **environment**.

From another viewpoint, autopoiesis seems to be constructed in a **hierarchical** way. Biological and even possibly biochemical autopoiesis in individuals and species alike, must have preceded physiological, psychological, mental and social autopoiesis. Each of these successive **levels** is a kind of stepping-stone for the next **emergent** more complex one. This could be the connection between higher **level order**, **emergence** by **dissipative structuration** and, most importantly, **nucleation** from one side, and successive **levels** of **organizational closure**, from the other.

F. CAPRA gives the following wide embracing significance of autopoiesis: "...the **pattern** of life (that is the **pattern** of **organization** of **living systems**, **dissipative structure**, as defined by Prigogine, as the structure of living systems; and **cognition** as defined initially by G. BATESON (1904-1980) and more fully by MATURANA and VARELA (1946-2001), as the process of life (1977, p. 160)

→ **Autogenesis; Epigenesis; Equipotentiality; Santiago theory; Zero-system**

0216

AUTOPOIESIS: About LUHMANN's view ⁴⁾

O. THYSSEN (1995, P. 13) characterizes as follows the way LUHMANN (1927-1998) extends the concept of autopoiesis: "LUHMANN generalizes the concept to cover not only **living systems**, but also mental and **social systems**. Whereas **living systems** operate in the medium "life", mental systems operate in the medium "**consciousness**" and **social systems** in the medium "**communication**". According to LUHMANN, a **social system** does not consist of human beings or **artifacts**. It consists of an ongoing stream of **communication**". THYSSEN has some problems with these views: "An **autopoietic system** is closed"(Note: i.e. *organizationally closed*) "It has no contact with the **environment**"(Note: it is however *structurally coupled* with it. Is that not a "contact"?). THYSSEN adds: "A disturbing consequence is that mental and **social systems** are totally distinct. No analysis of **consciousness** will ever reveal anything about **brain processes**, which are the domain of **living systems**"

One wonder if it is not the reverse: could not **brain processes** reveal something about **consciousness**. And: "Another disturbing consequence is that LUHMANN has no place for the individual. This point is methodological, not normative or "antihumanistic".(Ibid)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

MAN is a very diffuse idea allowing references to many different systems which do not have MAN as an **element** and which do not form a unity: no **supersystem** encompasses living, mental and **social systems**. So what is MAN depends on who is observing and how. KORZYBSKI (1879-1950) could have said it: MAN is a high level abstract "**label**" that should be used very carefully.

The hinge of the problem is obviously that any **social system** depends on *individual observers* in two complementary ways:

- 1- In any **activity** the **structural coupling** with the **environment** of the **social system** is through individuals (which make a kind of porous frontier with the **environment**)
- 2- The internal **autopoietic behavior** of the system as a **whole** depends on myriads of interindividual **structural couplings** as **observers** of each others

0217

AUTOPOIESIS and EVOLUTION^{1) - 4)}

The concepts of **autopoiesis** and **evolution** are difficult to connect in a satisfactory way. Various critical angles must be considered.

1) **The autopoiesis of individuals:** **Autopoiesis** seems to preclude any acquisition of new characters by individuals, as it implies **organizational closure**. Such is at least the case *immediately after the creation of a new individual*. However, impacts from the **environment** may still be received, which will potentially modify some characters, in very exceptional cases transmissible to the descendants. If otherwise, no **evolution** (nor genetic engineering) should be possible.

2) **Variability of a population:** Genetic recombination allows **populations variability**, but then only within the **limits** of the global genetic stock in existence. However, this stock may have been potentially impoverished or, on the contrary increased by the effects of inheritance by some individuals of mutations undergone under impacts from the **environment**, received by individuals of a former generation.

3) **Effects of mutations:** Lethal mutations are those which destroy the **viability** of new individuals for not being compatible with their basic **control subsystem**. Acceptable ones are those compatible with the **constraints** proper to the species and, as such, "written" in the **control subsystem** of the individuals (See the concept of "**Stellar system**" of A. MALINOWSKY).

4) **Radiative evolution:** If acceptable mutations are to become registered within the **control subsystem** and in accordance with the already existing **constraints** proper to the species, then every species may become the origin of a wide variety of new species. However, as the species **control subsystem** (partially represented in every individual) is **autopoietic** (i.e. **organizationally closed**), it will never – at

least in natural conditions – be possible, starting from the present type, to regress to former types.

5) **Mega-innovation by association:** It seems that, at some very infrequent times in the **process of evolution**, the **association** of numerous similar individuals, grouped within different functional units, produced the **emergence of heterogeneous systems** of a higher degree of **complexity**. In such systems a higher order central **control subsystem** is needed and it seems to surge spontaneously (i.e., through a **process** still not yet quite well understood). The present global **transformation** of mankind into a hypercomplex global system is, possibly, an example.

0218

AUTOPOIESIS and the "IMMANENT QUESTION"³⁾

The concept of "immanent question" has been introduced by G. BATESON in "Steps to an Ecology of Mind". (1973, p.371)

However the first example given by him comes from biology: "Consider the case of the unfertilized frog's egg for which the entry point of the spermatozoon defines the plan of bilateral **symmetry** of the future embryo.... The prick of a hair from a camel's-hair brush can be substituted and still carry the same **message**... But the internal **context** into which the **message** comes must be exceedingly complex. The unfertilized egg, then, embodies an immanent question to which the entry point of spermatozoon provides an answer" (Ibid).

This implies that the egg, the seed or, probably, the **brain** and even possibly the first germ of a culture, contains (in BATESON's words) an appropriate **structure**, i.e. the implicit **time-to-talized order** created from former **adaptation** and **evolution**. (see "order from noise", for a critique of the well known von FOERSTER's experience with magnets).

Autopoiesis seems thus to be the result of a **process** of progressive **emergence of order**, as the source of BATESON's "immanent question".

Remains to find out which is the prime mover of this **emergence**.

→ **Autogenetic system precursor; Zero-system**

0219

AUTOPOIESIS (S. BEER on levels of)^{1) - 2) - 4)}

In his paper on "Suprahuman Autopoietic Systems", F. ROBB explains in the following way BEER's views on **emergent levels of autopoiesis**

"Beer (1975) in specifying the conditions of **viability** of systems, conceptualizes the social world as containing "esoteric boxes" which, when strung together, form larger **organiza-**

tions. These esoteric boxes are not **closed systems** but they are more often than not **ultrastable**, resistant to **change**, and are "designed for **survival**". The **connections** between these **subsystems** are complex beyond **understanding**, transient, and **unstable**. It is the **networks of connections** that are dubbed "**metasystems**", and effective **control** over the assemblage can be achieved only if these **metasystems** can be defined and formalized, or as Beer puts it, "institutionalized". The design of a **metasystem** required to ensure an **organization's viability** entails that it should be capable of absorbing the **variety** generated by its lower-order systems and by the **environment of the whole**.

"The **metasystem** uses a higher-level logic and higher-order values than used by the **object systems** and these are the means of containing **variety** and of realigning the **objectives** of the esoteric boxes so that they serve higher-order **objectives**. Left to themselves, the **subsystems** will **suboptimize** and will not contribute to anything but their own **survival**. In any social **organization** there may be many **levels of recursion**.

"Beer's esoteric boxes appear to have all the properties of **autopoietic** systems. They are **processors** of self-production. They appear to be, before intervention **organizationally closed**. The institutionalization of their **metasystems**, which Beer calls for, may be seen as the attempt to open them so that their **autopoiesis** is destroyed and their **processes** directed toward the **autopoiesis** of the greater **whole**.

"To Beer, the intervention is made in order to understand internal **structure** and **behavior** and to redesign the **metasystemic** relations required if the **autopoiesis** of the **whole** is to be sustained. In this way, the "designed" **metasystem** is seen as a necessary artefact required to ensure that the **whole** satisfies the needs as expressed by the **objectives** of the highest (in logical order) **level**. Without this intervention the lower-order needs may be satisfied temporarily but at the very great risk that the **metasystemic** interconnections will be severed or dissolve as the **whole** disintegrates" (1989, p.59)

It should be pointed out that:

1- **Subsystems' autopoiesis** is probably not "destroyed", but more or less **embedded** and modified according to the autopoietic needs of the **whole**.

2- The **autopoiesis in levels** concept could likely be applied to all **levels of complexity**, starting possibly with the atom and the molecule.

3- Referring to "Suprahuman Autopoietic Systems", Robb himself emphasized that it is in no way obvious that social **metasystems** can be widely controlled by individuals. The opposite is quite more probable.

4- Beer's well known attempts to create global **monitoring** systems at the national **level** in various latin-american countries (Chile, Uruguay, Venezuela) may even seem somewhat paradoxical, knowing his own skepticism about the "surrogate worlds we manage" (1973).

0220

AUTOPOIETIC RELATIONS OF PRODUCTION^{1) - 2)}

In MATURANA and VARELA view, autopoietic systems count with an inherent **set of relations of self-reproduction**, i.e.

1. "The **relations** of constitution "that determine the **components** produced, constitute the **topology** in which the autopoiesis is realized"
2. The **relations of specificity** "that determine that the **components** produced be specific ones defined by their participation in the autopoiesis"
3. The **relations of order** "that determine that the concatenation of the **components** in the **relation** of specification, constitution and **order** be the ones specified by the autopoiesis" (1980, p.88 – as quoted by R.N. ADAMS, 1988, p.82).

0221

AUTOPOIETIC SYSTEM^{2) - 3) - 4)}

"A unity realized through a closed **organization** of production **processes** such that (a) The same **organization of processes** is generated through the **interaction** of their own products (**components**) and (b) a **topological boundary** emerges as a result of the same constitutive **process**" (M. ZELNY, 1981, p.6).

ZELNY comments his definition as follows: "... the **organization of components and component-producing processes** is maintained **invariant** through the **interactions** and **flux of components**" (ibid.).

F. ROBB thus resumes MATURANA's basic **concept**: "Autopoietic systems are characterized by circular **relations** which give rise to and maintain their autopoiesis. They define themselves, they are irreducible **objects** in nature, not defined by **observers**, they are self-producing and self-maintaining, they emerge from **instabilities**, and they have properties not possessed by their **components**" (1990, p.394).

The comment about "irreducible **objects** of nature" is intriguing: it could possibly be considered as a base for a systemic **ontology**.

However, when H. MATURANA and F. VARELA write: "**Living systems**, as physical autopoietic **machines**, are purposeless systems" (1980, p.86), one wonders if there may be a danger that some could interpret autopoietic **machines** as solipsistic (or autistic!) **machines**.

Seemingly, an autopoietic **observer**, for instance, must, to begin with, **construct** his/her internal **organizational closure**, even if this **process** begins before birth, in the guise of physiological **organizational closure** through genetic and **generative** heredity.

As conjectured by ZELNY, any autopoietic system would need to be a society, whether of **cells** in a **living system**, ants in an anthill, neurons in the **brain**, human beings in an **organization**, and even possibly in a near future elemental **robots** in systems of **distributed artificial intelligence**.

It has also be argued, by F. ROBB, that: "... there are strong reasons to believe that ever-higher order social **processes** can **emerge**" (1990, p.394).

Biotopes as well may be considered up to a point as autopoietic systems, when not seriously disturbed by outside **perturbations**.

Amanda GREGORY states: "The autopoietic system is structurally coupled to its **environment**: it responds to environmental **perturbations** by producing a feasible **set of responses**, in such a way to maintain its autopoietic **state**, from which the **environment** selects" (1996, p.571)

Thus the autopoietic system is equipped to oppose a strong resistance to **change**.

Accordingly, A. GREGORY examines in her paper the difficult relation between external evaluators and the (internal) managers of human **organizations**, which autopoietic character at times leads them to be highly resistant to **change**.

0222

AVAILABILITY¹⁾

Existence in the **environment** of the **resources** needed by the system.

Availability must be permanent or, at least, exist at any moment the system is seeking the **resources** it needs.

This is a condition of **survival** for any system, even if the normal **input source** can be in some cases replaced, at least temporary, by an alternative more or less equivalent **source**, or by **reserves** stored within the system itself.

Availability can be affected by variations in the **environment**, spontaneous or provoked by the system's own **action** or by **competition** between various systems.

0223

AVALANCHE²⁾

A very quick succession of **changes** triggered by a minimal **perturbation**, in a **network** or a **composite system** in a **critical state**.

An avalanche is a **percolation phenomenon** and is submitted to a **power law distribution**.

According to P. BAK and K. CHEN: "An avalanche is a type of chain reaction or **branching process**" (1991, p.28). Good examples are the propagation of an earthquake, of a forest fire or of a mud or snow slide.

In **composite systems**, the possibilities that such avalanches could propagate, depend on the characteristics of the **network** and, particularly on the existence of more or less extended stable "islands". (Blocks of **frozen elements** as described by St. KAUFFMAN, 1993, p.67)

Avalanches imply the existence of conditional **interactions** between **elements** in a more or less loose **network**.

P. BAK writes: "Large avalanches, not gradual **change**, make the link between quantitative and qualitative **behavior**, and form the basis for **emergent phenomena**" (1996, p. 32)

This is significant not only for physical **phenomena**, but also for economic and sociological ones: "If this picture is correct for the real world, then we must accept **instability** and **catastrophes** as inevitable in biology, **history** and **economics**" (ibid).

History here covers political and social upheavals.

And: "Because the outcome is **contingent** upon specific minor **events** in the past, we must also abandon any idea of detailed long-term **determinism** or **predictability**" (ibid).

This does not however seems to be **absolute**: "detailed" defines the basic meaning of this sentence. We still have a kind of overall **long-term stochastic determinism**, related to **self-organized criticality**. Earthquakes for instance are frequent along some known geological fracture lines, and rare elsewhere. In **time**, their **frequency** is relatively defined by a specific **power law** (Gutenberg- Richter Law) (ibid, p.13)

0224

AWARE OF¹⁾⁵⁾

It is significant that the word "aware" is generally used with "of".

Obviously awareness is always the result of some relation between a percipient **observer** and some **event** or **situation** in his **environment**.

The crux of the matter is finding out how exactly such **interactions** take place, which consequences they produce and which more precise **meaning** we can give them after a cautious critical evaluation

0225

AWARENESS¹⁾⁵⁾

The awakening of alertness and attention triggered by any specific **perception**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Awareness is frequently used as a synonym for **consciousness**. This seems to be rather unfortunate, as **consciousness** is the ultimate state of awareness, if used in the **meaning** of a capacity to reflect on one's own **perceptions**, as integrated and more or less clearly formulated by a human **brain**.

However, as expressed by F. Capra, this is "a key character of human **consciousness**". Thus "for a thorough understanding of the general **process of cognition in living systems** it is thus important to understand how human **consciousness**, with its abstract thought and symbolic concepts, arises out of the **cognitive process** that is common to all living **organisms**" (1997, p. 286)

In fact, awareness in its first state, can be only minimally distant from non-awareness. An example could be the passage from a merely dim **perception** of cold weather to a much clearer perception of what it means for the **observer**: 1) "It feels very cold. 2) Let me have a look on the thermometer for a more precise **evaluation**"

Awareness leads to focused attention and normally to a more selective orientation of **perception**, that may in last resort become clearly **intentional**. This sequence can already be observed in animals like dogs or chimpanzees

In many cases it leads to specific **action** and is thus a prime mover of selective **behavior**.

0226

AWARENESS (Critical) ¹⁾²⁾³⁾

Awareness is a very ambiguous notion. Everybody believes being "aware". But the fact is that there are many different forms and qualities of awareness. Critical awareness is widely discussed by M. JACKSON in his most recent book (2000, p. 356), as a basic foundation for **systems thinking** in general.

JACKSON basically distinguishes a hard **approach** and a soft one to complex **situations** and **issues**. He quotes CHECKLAND's opinion that "hard systems thinking is guided by functionalist **assumptions**: the world is seen as made of systems that can be studied objectively and that have identifiable **purposes**" (Ibid).

Leaving aside the "observing systems" problem (von FOERSTER, 1981), the most favored tool of hard system thinking will be **linear causality** or, at most, a kind of cybernetical **mechanicism**. In short, the quality of awareness depends on the **range** and quality of **perception** and on the limits of our conceptual **frame of references**.

JACKSON commends a wider sociological approach to the awareness problem: "with CHURCHMAN, ACKOFF and CHECKLAND, systems thinking becomes much more subjective, and the emphasis shifts from attempting to model systems "out there" in the world toward using **systems models** to capture possible

perceptions of the world". Furthermore this leads to "structure and enhance debate among **stakeholders**" so that an **accommodation** about **action** to be taken can emerge" (Ibid)

In short, critical awareness should be kind of stereoscopic or **holographic**. This view should meet JACKSON's conclusion: "Critical awareness, incorporating social awareness, became one of the central principles of critical systems thinking and remains so to this day. The main problem, of course, is that the apparent strengths and weaknesses of any particular systems approach will vary dramatically depending upon the **paradigm** from which it is observed and judged" (Ibid., p. 357). And moreover: "Critical awareness involves... criticizing the theoretical underpinnings, strengths and weaknesses of available systems **methodologies** and the usefulness of the **variety** of systems models, **methods**, **tools** and techniques in the service of different methodologies" (Ibid, p. 375)

0227

AWARENESS (Levels of) ¹⁾⁵⁾

Levels of awareness seem to be depending on the growing **levels of complexity** of the **nervous system** and the **brain** all along the evolutive lines of animal species

It has much to do with the **activity** chain that starts with **perception**, follows with **perception** interpreted as a **signal**, and ends with some **behavior** triggered by the **signal**

The following **levels of awareness** should be tentatively considered:

- **perception** (in all cases the basic condition for any awareness)
- inner **interpretation** of perception as a "**signal**" (this already supposes a previous training)

The capacity of **interpretation** broadens, widens and deepens until it reaches the aptitude for finer and finer **distinctions** in **categorization** and, finally, more and more capacity for complex **abstraction** and self reflecting **representation**.

- enhanced individual awareness obtained through reciprocal signaling within social **frames**. Such frames also become ever more complex from social amoeba to human societies
- the possibly questionable level of collective awareness in societies and **cultures**

Archaic forms of such collective awareness can be observed in beehives, termites mounds and ants nests.

0228

AWARENESS (Self) ¹⁾⁵⁾

The capacity to clearly perceive oneself as a separate entity

As noted by F. Capra, self-awareness, as far as we know, is manifest only in higher animals and fully unfolds in the human mind" (1997, p. 287)

He adds: "As humans we are not only aware of our **environment**, we are also aware of ourselves and our inner world. In other words, we are aware that we are aware. We not only know; we also know that we know. It is this special faculty of self-awareness that I refer to when I use the term "**consciousness**" (Ibid)

It can also easily be observed that the degree of self-awareness varies widely among human individuals, from about non-existent to acute **consciousness** in the case of mystics, "illuminated" or "awakened" (in the Buddhist sense) Capra also observes that "In the **Santiago theory**, self-awareness is viewed as being tied closely to **language** and the **understanding of language** (as) approached through a careful analysis of **communication**"...and "**Communication**, according to Maturana, is not a **transmission of information**, but rather a **coordination of behavior** among living **organisms** through mutual **structural coupling**. Such mutual **coordination of behavior** is the key characteristic of **communication** for all living **organisms**, with or without **nervous system**, and it becomes more and more subtle and elaborate with **nervous system** of increased **complexity**" (Ibid)

→ **Brain** (Triune)

0229

AWARENESS vs. CONSCIOUSNESS ³⁾⁴⁾

According to Susan Blakemore, awareness is a moment-to-moment **phenomenon** (2002, p. 26).

It is the result of instantaneous **perception**, that can be repetitive, but in a **discontinuous** manner.

Moreover awareness is always awareness of "something". It necessarily supposes an **experience** of some **event** "there outside". But the experience is "inside" as it is basically a complex **computation process** in a **neural network**.

It is also automatic. We do not need to decide that we are going to perceive: we just do.

As our **nervous system** possesses somehow the faculty of remembering former **experiences** we easily gain the impression of a **continuity of consciousness**. In fact it seems that this is also a construction in our **nervous system** which somehow throws bridges between these **discontinuous** moments of awareness.

The nature of the bridges is probably related to the continuous existence of a neuronal net in our **brain**, which becomes repeatedly reorganized after each **experience**. This is the gist of Maturana and Varela concept of **Autopoiesis**. (- see J. Gran, 2002, p. 46-49)

→ **Hippocampus**

0230

AXIOLOGICAL HYPOTHESES versus AXIOMS³⁾

J.W. SUTHERLAND says that the negation of POPPER's caveat about embracing creeds, "transforms axiological hypotheses into axioms" ... in which case "...the role of the scientist is displaced by that of the rethorician" (1973, p.107).

Since most, if not all of the **General Systems models**, are patently axiological hypotheses, **generalists** should be careful not to fall in the trap signaled by POPPER.

0231

AXIOLOGY³⁾

The discipline that studies the nature of **values**.

Systemics has an impact of axiology mainly for the following reasons:

- As it instates a **hierarchy** of **embedded** and **interdependent** systems, it should lead to a re-examination of the **rights**, **responsibilities** or reciprocal **needs** of each system and **co-system** within the corresponding **supra-** and **infrasystems**. This subject embraces a wide range of disciplines, from ecology to psychology and sociology.
- As it introduces a strong **time-dimension**, **needs**, **rights** and **responsibilities** must be considered within a future perspective, corresponding to different **time scales**.
- As it proposes a specific way to understand the relation of the **observer** with the observed, and peculiarly, the relations among various **observers**, systemic axiology needs to focus on **consensus** and **co-participative decision making**.
- As systemics introduces a new **understanding** of the nature of cultural differences, systemic axiology must also strive to find satisfactory transcultural **values**.

B

0232

BABEL TOWER EFFECT¹⁾

The growing incommunication between specialists of all trade resulting from increasingly partialized specialization.

While specialization is the condition of **efficiency** and genuine well founded **knowledge** in every specific trade, it also provokes a growing disconnection between specialists, as a result of the **emergence** of specialized jargons.

Systemics tries to create **meta-concepts** and a **metalanguage** of **isomorphic** or **homomorphic models** whose **validity** should cover as wide specialized areas as possible. It does not intend in any way to replace or reinvent specialized **knowledge**. Its real main aim is to

reestablish a higher degree of reciprocal **understanding**, in particular when numerous specialists must collaborate in the **management** of a complex **situation** or the **co-participative design** of some project.

0233

BACKGROUND¹⁾

The significant **environment**, past and/or present, of a **percept**, **representation** or **concept**.

The background is not taken into account until, for some reason, it becomes modified in a way that affects the **observer**. This is the case, for instance, of normal gravitation... until there is an earthquake, or for an astronaut floating in outer space.

However, a unperceived part of the background can be significant: nuclear irradiation can kill without being perceived.

The background can also silently accumulate slow **changes** that may suddenly **trigger** some **catastrophic effect**.

From a systemic viewpoint, an unobstrusive **monitoring** of the background can thus be very useful.

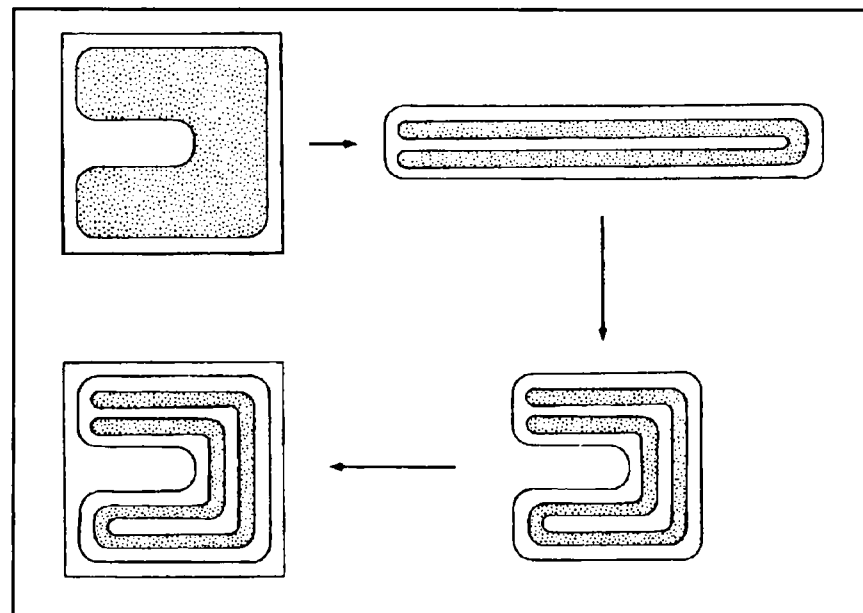
→ **Invisibility**

0234

BACKSIDE BALANCE⁴⁾

A kind of **behavioral feedback** that tends to restore dynamic **equilibrium** in a distorted economic or social relation.

Figure: see entry **BAKER's TRANSFORMATION**



The Baker's transformation as applied to Smale's "horseshoe"

From I. EKELAND: 1984, p. 90.

The notion has been introduced by M. MARUYAMA (1994, p.35), who calls it "backside system". It seems better here to avoid the use of the word system, because the backside **reaction** is not in itself a system, but a device or **process** within a system.

MARUYAMA gives various examples of this kind of **adaptive regulation** in distorted systems. "The combination of low wage and off-the-job income in South America, and low wage and multiple employment in Hungary until 1992, are also examples..." (Ibid)

MARUYAMA makes this very important observation: "Quite often, the backside system is invisible to outsiders" (Ibid)

0235

BAKER's TRANSFORMATION²⁾

A **topological** transformation which helps to visualize the **chaotic fractalization** of **processes trajectories** in **complex systems**.

I. PRIGOGINE and Y. ELSKENS describe the Baker transformation of a unit square as "a piecewise **linear area-preserving mapping**" (1986, p.211)

PRIGOGINE describes it as follows: "(it) owes its name to the association with the kneading of dough... Beginning with a square, we first flatten it into a rectangle. Then we fold one half of the rectangle on top of the other half to form a square again. This set of **operations**... may be repeated as many times as one likes. Each time the surface of the square is broken up and redistributed. The square here corresponds to the **phase space**. The baker transformation takes each point from its original positions to a new, but perfectly well defined position... Al-

though the series of points obtained in this way is "**deterministic**", the system displays in addition some irreducibly statistical aspects" (1980, p.77).

As explained by J. CASTI: "The stretching and folding operations are complementary, in the sense that the first separates points, while the second tries to bring them back together again – but with new neighbors" (1994, p.91).

He adds: "There are two directions in which the points can move: up/down and left/right. So there are two rates of separation, one in the vertical direction, the other in the horizontal" (p.100).

The baker's transformation is a **model** of how a **deterministic process** can produce a **chaotic behavior**.

see figure page before

0236

BALDWIN Effect ²⁾

D. DEPEW writes: "The general idea of the Baldwin effect is that learned **behaviors** can affect both the direction and the speed of evolutionary **change**. If an **organism** changes during its lifetime to acquire **habits** or exhibit behaviors which permit more effective **interaction** with its **environment**...it will probably leave more offspring" (2000, p. 7)

In this way a connection is established between **ethology** (and even **ecology**) and **evolution**. The idea reminds also somehow of LA-MARCK's view about "heredity of acquired characteristics". In relation to DARWIN's view of evolution, it adds sense to the concept of **selection**.

Baldwin's idea, according to DEPEW is in need of "the articulation of new theoretical **frameworks** in which it may make sense" (ibid)

More generally, it is obviously related to the ways adaptive or evolutive change in **elements** or individuals affects the group of the **social system**. In **modeling** terms, it would be the reconstruction of the "**metasystem**" from **bottom up**, or the subtle contradictions and complementarities between **autopoiesis** (Maturana), **homeostasis** (Cannon), **emergence** (Priogine), **autogenesis** (Csanyi) and **variety** (Ashby).

No doubt: the debate is far from concluded. But the collection of papers published by "Cybernetics and Human Knowing" is a quite significant step. (7(1), 2000)

→ **Renormalization group; Somatic ecology**

0237

BASE RATE ¹⁾²⁾

The general **probability** of an **event** to occur.

Such a rate is more easy to determine for frequent **events**, as for example the occurrence of rainy or snowy days in New York, than for rare **events** as for example hurricanes in Miami.

0238

BASE RATE EFFECT ²⁾

"The effect that the **chances** of an **event** occurring at all - its base rate - have on our ability to predict it" (R. MATTHEWS, 1997, p.25)

The more infrequent an **event**, the less we can predict its occurrence.

This has practical consequences. MATTHEWS states: "Its central lesson - that rare **events** are hard to predict - could... save us from spending millions on what may well be scientific wild goose chase". As a possible example, the author gives the prediction of earthquakes, a costly research until now "without a single unequivocal success" (p.31).

Criticality theory helps to understand the deeper reasons of such failures.

0239

BASELINE ¹⁾

Existing conditions and **trends** in the **activity** of a system before any modifying **action** occurs.

It constitutes a bench mark **state** from which **knowledge** is needed for the **evaluation** of any natural or projected purposeful **change**.

It is also useful for consideration of non-action alternative

0240

BASIN BOUNDARY ^{1) - 2)}

The **set** of points that defines the outer **limit** of a **basin of attraction**.

The crossing of this boundary due to some **perturbation** knocks the system out of the basin and either sends it into some other basin corresponding to another **attractor** or readily destroys it.

However, according to R. THOM, the basins relative to two **attractors** can penetrate each other in a **topologically** complicated way, with a quite undeterminate outcome (1972).

See **Basin erosion**

0241

BASIN BOUNDARY (Fractal) ²⁾

The boundary of a **fractal basin of attraction**.

Nonlinear systems have in many cases **trajectories** submitted to **chaotic attractors**, which can be very complex, i.e. they may have a very wispy micro **self-similar structure** (homoclinic tangles; SMALE's horseshoe, etc...).

Such systems are very difficult to describe, to monitor and to control.

0242

BASIN EROSION ²⁾

The progressive invasion of a stable **basin of attraction** by **instabilities** generated by a **chaotic attractor**.

During this **process** the basin is progressively divided into layers of smaller and smaller **regions of stability** and of **instability**, i.e. becomes **fractalized**.

In such a case, the basin may become "... so thin or wispy that small **disturbances** can knock the system out of the basin to **converge** somewhere else" (A. McROBIE & M. THOMPSON, 1990, p.45).

These authors add: "To be safe any engineering system must have its **attractor** at a prudent distance from its **basin boundary**. Structural engineers refer to failure as "exceedance of the ultimate **limit stage**". Once a **structure** passes this condition, it will **collapse**" (ibid.)

This quite insidious **process** of loss of **stability** is responsible for numerous structural disasters in buildings, ships, airplanes, bridges, etc. submitted to external **disturbances** like winds, **overload**, collisions, small seismic movements, etc...

It is also present in celestial mechanics, where H. POINCARÉ first met it in the study of Saturn rings.

0243

BASIN OF ATTRACTION ^{1) - 2)}

The **region** that includes all the **trajectories** corresponding to an **attractor** in a system's **dynamics**.

A specific basin corresponds to each **attractor**.

The global **state space** consists of a **set** of **basins**, that are isolated from each other by **separatrices**. In the neighborhood of a **saddle**, basins **limits** become **unstable**, and a **trajectory** can jump from one basin to another (A **catastrophe event**).

This abstract concept can be intuitively visualized through the example of a river basin, in which **flows** circulate in a structured **space**. The general character of a basin implies, in K. KRIPPENDORFF's words: "... that no **state** in one basin succeeds or is succeeded by **states** in another basin and any two **states** in one basin share at least one preceeding **state** or successor" (1986, p.5-6). Every basin thus defines some specific **dynamics**, and inhibits any other.

To different kinds of **attractors** correspond different types of basins.

0244

BAYESIAN PROBABILITIES

→ **Probabilities (Bayesian)**

0245

BAYESIAN SYLLOGISM¹⁾⁽³⁾

The Bayesian syllogism has been introduced by V.V. NALIMOV and is based on Bayes probabilistic logic (1982, p. 284).

In NALIMOV's own terms: "It becomes possible to speak of the Bayesian syllogism. It may be regarded as a generalization of ARISTOTLE's syllogism (i.e. the categorical syllogism in which two initial categoric assertions linked by the common middle term yield the third judgement called the **inference**..., an assertion of absolute **value**, independent of any conditions).

"Whereas in the Aristotelian syllogism the inference is a logically clear assertion, in the Bayesian syllogism the inference is the redistribution of weights in the system of initial value **concepts**, determining the trend of thought on the logically structured **level**" (Ibid)

In a later work, NALIMOV adds: "In my interpretation, the Bayesian formula well known in statistics acquires a new **meaning**. From an auxiliary computational formula, broadly used in mathematical statistics, it turns into one setting the logic of propositions" (1985, p. 28)

→ **Bayes theorem; Bayesian probabilities; Parallel distributed processing**

0246

BAYES's Theorem²⁾

R. MATTHEWS (1997, p.38) explains Bayes's theorem as follows: "(The) theorem shows how to update your belief in a particular theory in the light of new **data**. Mathematically, it states:

Odds (Theory, given observed data) = LR x Odds (Theory)

where Odds (Theory, given observed data) are the odds on the correctness of the theory, given the new **data**, and Odds (Theory) are the so-called prior odds that the theory is correct - that is, a measure of the plausibility of the theory before the new **data** emerged. Precisely how that new **data** changes your beliefs is captured by the so-called "**Likelihood Ratio**" (LR), which is made up of two factors:

LR = Prob (getting the data, given theory is correct)

Prob (getting the data, given theory is wrong)"

BAYES's Theorem helps dealing with statements "that lie somewhere between absolute truth and falsity" (R. MATTHEWS, 2000, p.45). This is crucial for the **evaluation** of the soundness of any scientific result (and any belief in general), because, as **observers**, we have no way to appreciate "absolute" truth or falsity.

MATTHEWS explains: "... as you accumulate more **information**, BAYES's theorem shows that your original thoughts - flaky or well founded, right or wrong - become progressively less important... The scientific process contains

an ineluctable amount of **subjectivity** at the onset, but... it gives way to **objectivity** as the **information** accumulates. In other words, scientific **objectivity** is "emergent" (p.45).

It would be possibly better to say that it is "asymptotically emergent", because it is impossible to totally eliminate **subjectivity**. This **process** is closely related to POPPER'S **false-ability**. It is also obvious that asymptotic **objectivity** is better reached by recurrent debate and **consensus**.

→ **also: Epistemo-praxeological closure; Observability (Constraints on); Observation process; Probability (Bayesian)**

0247

BEHAVIOR^{1) - 4)}

1. "The system of interconnected and expedient **actions** carried out by an **organism**" (UNESCO-UNEP, 1983, p.6)

2. A repetitive sequence or **pattern** of **actions** or **operations**, and resulting **states**, characteristic of a specific system.

The second definition is more general than the first, since it can apply to non-living **systems**, as well as to societies of **organisms**.

The concept of behavior, when referring to a **complex system**, may be associated with an interconnected **network** of **actions**.

G. PASK gives the following examples: "The behavior of a steam engine is a recurrent **cycle** of steam injection and piston movements that remains invariant. The behavior of a cat is made of **performances** like eating and sleeping and, once again it is an **invariant** form selected from the multitude of things a cat might possibly do" (1961, p.18).

Models of numerous different behaviors can be constructed, but one **model** may be used to modelize analogous behavior of different systems, as for example cyclical **oscillations** in **homeostatic systems**, or **dissipative structuration** in **systems far from equilibrium**.

Behavior is thus a systemic-cybernetic concept of very ample significance and does not exclusively and necessarily have psychological overtones.

However, as stated by R. ESPEJO: "The greater the number of distinct behaviors that are recognized in a **situation**, the more complex it appears to be" (1988, p.140)

From a somewhat different **viewpoint** G. KLIR defines behavior as: "A particular **set** of **time-invariant relations** between certain quantities". He then proceeds to define three basic kinds of behavior:

Table: see entry **Behavior**

Type of system	Behavior of system	Outcome of behavior
State maintaining	Variable but determined (reactive)	Fixed
Goal-seeking	Variable and chosen (responsive)	Fixed
Multi-goal-seeking and purposive	Variable and chosen	Variable but determined
Purposeful	Variable and chosen	Variable and chosen

"1. **Permanent (real) behavior** - the **set** of all absolute **relations**;

"2. **Relatively permanent (known) behavior** - the **set** of all relative **relations** of a particular **activity**;

"3. **Temporary behavior** - the **set** of local **relations** within a distinct section of a particular **activity**". (1965, p.30)

He adds: "It should be remembered that permanent behavior is known only in some cases, e.g., when it is directly given in some engineering system" (Ibid)

Still from another perspective, A. ROSE-NBLUETH, N WIENER and J. BIGELOW (1943, p.22) proposed a **classification** of orders of behavior.

In turn, R.L. ACKOFF establishes the following behavioral **classification** of systems (1971):

see table below

0248

BEHAVIOR (Active)²⁾

"A system's **behavior** is determined not only by the **state** and influence of the **environment**, but also by the system's own **goals** presupposing the **transformation** of the **environment**, its subjection to the system's need" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.120).

According to these authors: "...in a system with active **behavior**, a crucial role is played by the **teleological** characteristics of the system itself and of its separate (i.e. distinct) **subsystems**, and by the **interaction** of these characteristics" (p.130).

Active behavior is possible only for a system endowed with **regulation** and **control mechanisms**, which must include a **knowledge** of its own **state** and that of its **environment**, including some **knowledge** of **past states**.

This concept makes sense particularly in connection with **autonomous** (= **autopoietic**) **systems**.

0249

BEHAVIOR (Adaptive)^{*}

→ **Adaptive behavior**

0250

BEHAVIOR (Anticipatory)^{1) - 2)}

The activity of a system that constructs a predictive **model** of itself, its **environment**, or both, in order to adapt itself to probable future **change**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

R. ROSEN found that such behavior is quite general in **living systems** of all kinds, even if at very different **levels** of systems **complexity**.

The notion of anticipatory behavior should be handled in a discerning way, in order to avoid logical contradictions: future **events** cannot of course exert influence on present ones, but what is *now correlatively* perceived or believed about what will probably or possibly happen, can. ROSEN gives the following example: "Many primitive **organisms** are negatively phototropic: they move toward darkness. Now, darkness in itself has no physiological **significance**; in itself it is biologically neutral. However darkness can be *correlated* to characteristics which are not physiologically neutral, e.g., with moisture or with the absence of sighted predators. The relation between darkness and such positive features composes a *model* through which the **organism** predicts that by moving toward darkness, it will gain an advantage" (1979, p.15).

This action of a *present prediction* upon the *present* behavior acts as a **regulation** or **control** and is called **forward activation**, the result of a **feedforward**.

ROSEN adds: "Of course this is not a conscious **decision** on the **organism's** part; the **organism** has no real option, because the **model** is, in effect "wired in" (p.544).

In animals with complex brains, however, particularly man, the **model** becomes much more complex and can evolve, becomes reflexive and self-corrective, and leads to changing **goal-directness**.

An obvious conclusion, stated by ROSEN (p.557), is the need for ever-perfected predictive **models**, in order to improve anticipatory behavior. This field should urgently be researched upon as to the anticipatory behavior of **social systems**.

→ **Club of Rome, Feedforward, System (Anticipatory) and Systems Dynamics**

0251

BEHAVIOR (Chaotic)²⁾

I. PRIGOGINE and I. STENGERS write: "A behavior is chaotic if **trajectories** outcoming from points as close as possible in the **phases space**, stray from each other in **time** in an *exponential way*". (1992, p.77)

This implies that, after a sufficiently long span of **time**, it becomes impossible to predict future behavior relying solely on the **initial conditions**. The authors explain that only a more accurate **knowledge** of these may better the **predictability** of behavior, but that such **knowledge** will rapidly become prohibitive in **costs** and in **time**.

While this is an abstract view, it corresponds to our practical **situation** in front of **complex systems** and it strongly limits our possibilities to govern them.

→ **Lyapounov exponent**

0252

BEHAVIOR (Coherent)¹⁾

The behavior of numerous **elements** or individuals which start to exhibit coordinated **interactions**.

This **phenomenon** can already be traced in physical effects (**BÉNARD's instability**) and chemical reactions (the **BELOUZOV-ZHABO-TINSKY reaction**). It heralds the **emergence** of higher **order structures** and, in living beings, of social **organization**.

0253

BEHAVIOR (Determinate)²⁾

G. KLIR thus characterizes determinate behavior (in **automata**): "The instantaneous **response** can be uniquely derived from the instantaneous **stimulus** and sometimes from past **stimuli** and **responses**; this is accordingly subdivided in:

1. **combinatorial** – the instantaneous **response** depends solely on the instantaneous **stimulus**;
2. **sequential** – there exists at least one **response** that depends not only on the instantaneous **stimulus** but also on the past **values** of some of the quantities" (1965, p.37).

KLIR opposes determinate behavior to **random** behavior

0254

BEHAVIOR (Eco-)^{1) - 4)}

The behavior of elementary units in a **network** as it becomes organized through their repeated **interactions**.

This **concept** has been promoted by J. ERCEAU and J. FERBER whose "... objective is to construct a society of **agents**... (true non-anthropomorphic micro-robots), capable of work within a hostile **environment**, and to improve their individual and collective **performances** through **mechanisms** akin to **learning**" (1991).

These authors include in their "society" reactive **agents**, communicating **agents**, rational ones and intentional ones. (See "**Multi-agents systems**").

In natural **ecosystems**, different types of behavior are distributed among different species or among various individuals of the same species. There appear to be a kind of spontaneous and distributed **control mechanism** peculiar to these systems.

Strikingly, eco-behavior could be used as a **model** for any type of **social systems**.

0255

BEHAVIOR (Eigen)

→ **Eigen**

0256

BEHAVIOR (Emerging)²⁾

Innovative behavior of a system or **network** that does not exist in any of its **elements** or **parts**.

Emerging behavior results from the combined **interactions** of some or many **elements**. Some of the **interactions** are simultaneous in different **parts** of the **network** or system, while others are sequential. This situation may lead either to what St. KAUFFMAN (1991) calls **anti-chaos**, i.e. **organization** at a higher level of **complexity**, or **deterministic chaos**.

In **multi-agent systems** global behavior emerges from the **interactions** of numerous "**agents**", whose abilities are more or less elementary and specific. This is a typical social **network situation**. It also seems to promise complex societies of simple **robots** in the future.

0257

BEHAVIOR (Functional)¹⁾

In order to be considered functional, any **behavior** must be **adaptive**, i.e. allow for a suitable **reaction** of the system to some **stimuli**.

However, functional behavior is more than a **functional reflex**, which is only a **response** to a **command**. A **functional reflex** may indeed endanger the system in some cases.

Functional behavior, even though its progress ceased at the reflex **levels**, involves the previous incorporation of a **variety** of possible reflexes into a **subsystem**:

1. which will be able to produce a considerable **choice** of distinct **sequences**, according to the general conditions (and not only to the specific **stimulus**)
2. which will be **integrated**, i.e. able to select the appropriate **response**.

0258

BEHAVIOR (Isopraxic)

→ **Isopraxic behavior**

0259

BEHAVIOR (Line of)²⁾

"A succession of **states** and **time-intervals** between them" (W.R. ASHBY, 1960, p.20).

ASHBY adds: "The first **state** in a line of behavior will be called the **initial state**. Two lines of behavior are equal if all the corresponding pairs of **states** are equal, and if all the corresponding pairs of **time-intervals** are equal" (p.243)

This is of course the basic condition for **homomorphisms** and **isomorphisms** between functional **models**.

0260

BEHAVIOR (Operative)¹⁾⁴⁾

The behavior of a **decision** maker or **operator** when trying to manage a system or correct some **disturbance** in a **function** of the same.

The following types of operative behavior have been identified:

- **skill-based behavior**: it is similar to an automatic behavior, practically without mental **activity**. The **operator** only reproduces behavioral **models** acquired by intensive **training**. Any alarm functions as a **trigger** for a kind of **conditioned reflex**
- **rule based behavior**: this behavior supposes a conscious mental **activity** and is characterized by the sequential **performance** of coordinated **tasks**, according to learned or written well assimilated **rules**
- **knowledge-based behavior**: the **operator**, in a more complex and not very common **situation**, must understand the problem, plan adequate **responses** and execute the corresponding **decisions**. This behavior generally includes reasoned **choices** made in due time on the base of a proper **understanding** of systemic **complexity**. A high level of personal **responsability** can be achieved in this way.

A frequent and very dangerous error is to give **responsibilities** of this last level to people trained only for **rule- or skill- based behavior**.

Human behavior in operative **situations** and in relation to mental **activity** seems to respond to the three following basic types:

- **Skill-based behavior**: a practically automated behavior generally produced by a long **training**. Such behavior allows a very quick and efficient operative **response**, but then only in situations similar to those met during the **training process**. The skill acquired by a pianist for example is rigorously related to the universal standard board of pianos
- **rule-based behavior**: a less automated behavior, in which a measure of mental **activity** is needed in order to select the correct behavior in different specific cases. Such behavior is not over-complex when the number of possible different cases is limited and corresponds to more or less similar or well known **situations**
- **Knowledge-based behavior**: an intelligent mental behavior needed to tackle quite complex and/or unusual **situations** wherein automated skills or **rule** application are wanting. In such cases an **operator** must be able to discover adequate procedures in **decision making** or in **design processes**.

→ **Christmas tree effect; Complexity; Decision tree**

0261

BEHAVIOR (Purposive)^{1) - 4)}

A. RAPOPORT observes that: "...mathematical analysis shows that the apparently purposeful behavior of the system is a consequence strictly deduced from the fact that it is **open**, not **closed**" (1966, p.8).

In effect, the need to process *specific inputs* of **energy**, **matter** or **information** in accordance with the internal nature of the system implies a behavior oriented toward the maintenance of defined internal **parameters**. This does not necessarily impose **consciousness**, and even less so, **teleology**.

We would probably have to distinguish between two types of purposive behaviors. The first one is, in animals, non-conscious *purposive* behavior (another semantic trap!) and the second is man's, based on **symbolic** capability (cf. L.von BERTALANFFY, 1967), that should be called *purposeful*.

Evolutionary **differentiation** seems to bear on a steadily growing capability to *create* new behavior within the **reference frame** of an already globally installed **understanding** of **environment** as well as **invironment**.

Such a capacity could be a result of the growing **variety** of effective and of potential neural **interconnections** in the **brain**, which provide the possibility of practically unlimited recombinations.

0262

BEHAVIOR (Random)²⁾

G. KLIR characterizes random behavior (in **automata**) as the one in which: "... the **response** depends statistically on the instantaneous **stimulus** and sometimes also on past **stimuli** and **responses**, accordingly subdivided into:

1. simple, where the instantaneous **response** depends (statistically) solely on the instantaneous **stimulus**;
2. complex - there exists at least one **response** that depends (statistically) not only on the instantaneous **stimulus**, but also on the past **values** of some of the quantities" (1965, p.37). Complex random behavior thus seems to be a characteristic of **ergodic** or **markovian systems** in general terms.

0263

BEHAVIOR (Reactive)¹⁾

A system's behavior "determined by **environmental input** in all essential points" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.130).

0264

BEHAVIOR SCHEDULE¹⁾

A. LOTKA introduces this interesting **concept** as follows: "We may say ... that the **organism** goes through a certain **routine** of motions or

activities which are rendered possible by its **structure**, and which, in turn, are a necessary condition for the continued existence of that **structure**. These **activities** in general involve the expenditure of certain quantities of free **energy**, and a part of the **energy** so expended, is spent necessarily in collecting (earning) a "replacement" amount equal to the total expenditure, to balance the account, to cover the *cost of living*" (1956, p.346).

By connecting behavior with **structure** (in a reciprocal way), this **concept** bridges a gap between those of **dynamic stability**, **organizational closure**, **hypercycle** and **behavior** in general.

It is possible to describe behavior schedules in a quantitative way, for example, as shown by LOTKA, by an estimation of the normal use of earned calories.

Behavior schedules can be modified, for instance by adaptive ethological **changes** in **habits**.

0265

BEHAVIOR (Self-organizing)¹⁾

E. JANTSCH distinguishes "the following three basic types of internal self-organizing behavior:

- *Mechanistic* systems do not change their internal **organization**;
- *Adaptive* (or **organismic**) systems adapt to **changes** in the **environment** through **changes** in their internal **structure** in accordance with **pre-programmed information** (e.g., engineered or genetic **templates**);
- *Inventive* (or human action) systems change their **structure** through internal generation of **information** (invention) in accordance with their intentions to change the **environment**" (1975, p.66).

This latter type corresponds to Singerian **adaptation**.

In JANTSCH's opinion, it could very well derail into unforeseen and dangerous developments (p.64-66). In effect, short term ill-conceived **changes** may become harmful later on.

0266

BEHAVIOR SPACE²⁾

"The collection of behaviors a system can follow, the **set of paths** a system is capable of taking" (K. KRIPPENDORFF, 1986, p.6)

This concept is interesting in that the observed behavior during a **time lapse** is not necessarily the only possible kind, but merely a special one, corresponding to certain internal and/or external **conditions**. What "always" happens is no sure-fire guarantee of the future of the system or of one of its **processes**.

0267

BEHAVIOR (Specific action)⁵⁾

A type of **action** standardised in accordance with a specific task.

A specific **action** pertaining to a **pattern** of behavior can be repeated without any adaptive **variations** as many times as needed.

Only **machines** – mainly so-called **robots** – can be programmed for specific action behavior.

Living systems, particularly human beings, are not efficient specific behavior actors, precisely because they are good at adaptive **variations**.

H. COLLINS observes: "We can replace workers on **production** lines with **machines**, but only after we have organised the factory so that the tasks can be accomplished through standardised behavior, rather than varying **actions**" (1992, p.39).

Specific action behavior thus introduced as **algorithms** and **routines**, become completely stabilized and **context** independent.

COLLINS adds: "The theory of the specific action behavior... gives us a simple test which highlights most of the difficulties of making **machines** that mimic human **action**" (p.39).

This is true at least for **machines** guided by **algorithms**, but could become less so for **machines** trained by **learning**.

0268

BEHAVIOR (State-determined)²⁾

"A behavior is state determined if an **observer**, knowing the **state** at t , is able to predict the **state** at $t+1$ with certainty" (G. PASK, 1961, p.28).

G. PASK rephrases the concept in a still more precise way: "A behavior is state determined if $X(t+1)$ depends in a *unique* fashion upon $X(t)$ and, in the **phase space**, this means that the **path** describing a state determined behavior *does not bifurcate*" (Ibid).

As stated by G. PASK, a state determined behavior "must either converge... to a fixed **state**, called the **equilibrium** point, or enter a behavioral **cycle**" (p.29).

The **equilibrium** point is also called a punctual **attractor** and the behavioral **cycle** is inscribed in a **confluent** or **basin of attraction**.

0269

BEHAVIOR SYSTEM²⁾

A **model** of a **data** system assuming that the **relationships** among **variables** are invariant.

This **model** is introduced by G. KLIR who says that these **invariances** are so "with respect to the supporting **medium** involved" (1993, p.32). The **invariances** can be in **time**, **space**, **space-time**, **population**, etc.... Furthermore: "The **relationship** may involve not only **variables** contained in the experimental **frame**, but also additional **variables** defined in terms of the former by specific **translation rules** in the supporting **medium**. When the supporting medium is **time**, for example, we obtain **lagged variables**" (Ibid).

And: "We say that a **data** system is represented by a behavior system if, under appropriate **initial** or **boundary conditions**, the support-invariant **relation** of the latter can be utilized for generating **data** of the former" (Ibid).

→ **Reconstructability analysis**

0270

BEHAVIORAL ALGORITHM^{2) - 5)}

A genetically inherited or learned behavioral **pattern** that became stabilized.

J. CORBARA and A. DROGOU give the example of the three basic **patterns** of behavior of some ants: taking care of the brood, seeking fodder or being inactive. The different **patterns** are in that case activated or deactivated through social **triggers** (1993, p.835).

Behavioral algorithms seem very basic for carrying out in an economical way many **routine** tasks. Training, a more channeled way of **learning**, leads in many cases to the acquisition of such algorithms (e.g. swimming, using a **language**, driving a car).

0271

BEHAVIORAL CHAINS

→ **Action Chain**

0272

BEHAVIORAL PROPERTIES¹⁾

J.W. SUTHERLAND states: "...behavioral properties of any real significance are generally dependent upon a **context** for their **viability**" (1973, p.37).

This should be understood in two different senses:

1. Behavioral properties are basically "constructed" by the system in accordance with its genetic characteristics (corresponding to its **archetype**, as well as its proper, more specific ones), which reflects the historical adaptive **evolution** of the **archetype**.

2. More specific behavioral properties are variations on the basic ones, learned in accordance with the special **situations** encountered by the system in its **environment**.

0273

BEHAVIORAL SPACE²⁾

"The **set** of **paths** a system is capable of taking" (K. KRIPPENDORFF, 1986, p.6)

According to this author: "A behavioral space represents, sometimes graphically, and/or abstractly,... just what a system can do, so that what it actually does can be seen as a special case determined by **initial conditions**, circumstances, **purposes**, etc" (Ibid).

Behavioral space is to **processes** what **states space** is to possible **states** of the system.

0274

BEHAVIORAL UNCERTAINTY⁵⁾

A certain **level** of leeway in behavior.

While behavior must be more or less narrowly channelled by mental and psychological **algorithms** in order to respond efficiently to a wide **range** of variations in the **environment**, a degree of leeway is also necessary for **adaptation**.

Behavioral uncertainty is especially developed in man and gives him an increased power to select alternative **responses** when faced with hitherto unknown or unforecasted **changes**.

It tends however to decrease with **ageing**.

Cognitive maps, which are necessarily normative, tend to reduce behavioral uncertainty, but at the same time allow for it, at least in some measure.

0275

BEHAVIORISM^{3) - 4)}

The school of psychology that considers that it is objectively possible to observe and describe animal and human **behavior**, stresses the role of **environmental constraints** upon such **behavior** in terms of **inputs** (**stimuli**) and **outputs** (**responses**), and admits that it is possible to modify **habits** by appropriate conditioning.

While it offers some systemic aspects, it is not really possible to admit behaviorism as a systemic theory because:

- with its over-emphasis on **habits** to explain **behavior**, it tends to trivialize the **relationship** of the acting animal onto its world *as it perceives it*.
- it reduces **relationships** between the animal and its **environment** to over-simplified **feedbacks** (a kind of simple and very **deterministic mechanicism**).
- it gives little consideration to the internal **organizational closure** of the animal, considering it only as apt to be conditioned and thus denying it any measure of **autonomy** (at least in B.F. SKINNER's version of behaviorism).

There is a strong antinomy between behaviorism and **constructivism** or **autopoiesis**.

0276

BEING, DOING, BECOMING^{1) - 3)}

According to J.L. LEMOIGNE, "An **object's** definition is made by triangulation: it includes

- a functional definition (what the **object** does)
- an **ontological** definition (what the **object** is)
- a genetic definition (what the **object** becomes)" (1977, p.39)

LEMOIGNE adds that this "Triadectics of being, doing and becoming is probably the key of **representation**, if not even of **knowledge**" (Ibid).

This important insight reminds us that none of the three definitions corresponds to an absolute **knowledge**:

- What the system actually does may be quite different of what we believe it does, or of our specific viewpoint in relation to our research;
- We do not know if the "real **object**" corresponds perfectly to the **model** we did construct (see "Ontological skepticism");
- It is not secure that our **forecasts** in connection with the future of the **object** are valid, nor even that it would be possible to make any valid **forecast**.

The trialectic concept of LEMOIGNE's is basic for the whole of his "Système General" Theory (p.40).

W. PANKOW writes on the same topic: "Being is becoming. Self-transcendent systems are **time** generating systems. Being and **time** are complementary aspects of **gestalt**. **Gestalt** has no origin: it is its own origin" (1976, p.21).

0277

BELIEF¹⁾⁴⁾

"Mental acceptance or conviction in the **truth** or actuality of something" (Am.Heritage dict., p. 121, 1978)

Beliefs are very significant in individuals and in social systems. It is debatable if "acceptance" is "mental". It seems generally to be rather emotional.

In any case, for an individual, beliefs are a pre-ordering factor of **reference frames**, whether rational, esthetic, philosophical or religious. But a rational belief may lead one to question a religious belief, or conversely. Different kinds of beliefs lead naturally to different **decision making and behavior**.

In any human group, as for example a business, or a political party, common beliefs are the indispensable common ground without which **cohesiveness** cannot be maintained and **coherent behavior** be sustained.

This remains true even if these beliefs are implicit and never overtly proclaimed.

Similarly, different **cultures** are different precisely because the basic beliefs shared by individuals in any specific culture are at variance with the beliefs of other ones.

In any culture, the **set** of beliefs acts as a general behavioral **control**, because it compatibilizes and coordinates individual behaviors (in German: Gleichschaltung)

Moreover, its beliefs set endows a culture with a kind of **immunity** to encroachments from other cultures. Unfortunately this derives frequently into intolerance and reciprocal hostility between individuals or groups alien to each other.

→ **Clanthink; Community; Communities (types of human); Compatibility; Group-think; Human Systems; Language and Culture; Semantics (General); Systems (Cultures as)**

0278

BELOUSOV – ZHABOTINSKII REACTION^{2)–5)}

"A complex chemical reaction involving the cerium-catalyzed bromination and oxidation of malonic acid by bromate ions" (J.S. TURNER, 1982, p.48).

A now famous chemical reaction, whose relation to **nonlinear systemic processes** studies is thus described by TURNER: "The great interest of the Belousov-Zhabotinskii (BZ) reaction lies in its unique ability to exhibit a wide variety of characteristic **nonlinear behavior**. Ranging from **homogeneous** chemical **oscillations** in stirred reactors to travelling chemical **waves** and stationary spatial **structures** in unstirred mixtures, the **phenomena** observed in this system include all the types of **nonequilibrium** coherent **structures** that have been studied theoretically in the past decades. In the last few years, besides, new experiments have suggested that the same chemical **processes** which give rise to coherent **phenomena** may also yield incoherent or **chaotic behavior** as well" (p.48).

The BZ reaction is an example of a **reaction-diffusion system**, resulting from the competition of a force that tends to produce **dissipative structures** and another that tends to dampen them out.

0279

BÉNARD's INSTABILITY^{2) – 5)}

A **phenomenon** of **structuration of forms** through **energy dissipation**.

This **phenomenon** was discovered by the French physicist BÉNARD at the beginning of the 20th century, but its **general systemic meaning** was not understood until PRIGOGINE's discoveries in **thermodynamics of far from equilibrium systems**.

F. DAVID PEAT describes this kind of instability as follows: "It occurs when a pan of water is heated on a stove or when hot air in the desert lifts tiny particles of sand into the air. If the pan of water is heated slowly, heat at first moves upward into the cooler water by conduction. Since no part of the liquid is far from thermal **equilibrium**, the surface is smooth and undisturbed. However, as the water at the bottom becomes hotter, and therefore less dense, it tries to rise while, at the same time, cooler water falls from the top. Under these competing **flows** the water is now **far from equilibrium** and it contains a mixture of **flows**, eddies and whorls... In fact, **chaos** has set in.

"As the rate of heating continues to rise, however, a **critical point** is reached at which the whole system moves from **disorder** to **order**. This occurs when heat can no longer be dispersed fast enough through **random** movements alone and the tiny eddies suddenly become magnified into large-scale **flows**. Almost

magically, movement in the liquid shifts from **chance** into a series of stable convection currents which have the effect of producing a regularly ordered **lattice of hexagonal** currents.

"... millions upon millions of molecules suddenly move coherently rather than in a **random** way – a **phenomenon** that recalls the convergent movements of **cells** in the slime mold (Note: see *Dictyostelium discoideum*) or electrons in plasma." (1988, p.78-9)

→ **Hexagonal space filling; Structure (Dissipative)**

0280

BENEFIT per unit cost²⁾⁵⁾

The relation between a system's **input** and the **resources** that it must spend in order to obtain them.

This relation must remain positive, i.e. it should yield a better than average return, at least as a general mean.

This is a very general relation, that can be observed from Biology and Animal Ecology to Business and Economics

In Economics for example, it is expressed through marginal utility.

It obviously governs **behavior** in any system in its relations with its **environment**.

When the **costs** of obtaining needed **inputs** cross a specific **threshold**, the system is losing its balance. If this **situation** is not corrected, the system could be on its way toward **collapse** of bankruptcy.

→ **Foraging theory; Stability (Dynamic)**

0281

BIFURCATION²⁾

The splitting of a **trajectory** into two or more new **trajectories**.

Bifurcations characterize states of **uncertainty**.

They occur in the "**region of the parameter space** where a **state** of a system becomes **unstable** and gives way to a pair of **states** in which a new **order parameter** has a finite **value**" (R. FIVAZ, 1991, p.31).

According to this comment by FIVAZ, a bifurcation is thus characterized by the **emergence** of a qualitative change in the nature of an **attractor**. According to I. PRIGOGINE and G. NICOLIS; "... (a) bifurcation is basically a "**decision making**" process. But because of the multiplicity of **choices** at the "decision" point, a **selection mechanism** is necessarily involved. Now all physical systems possess such a mechanism, in the form of **random fluctuations** that are generated spontaneously around the **deterministic evolution**" (1985, p.6)

Of course, "**decision making**" in physical systems does not imply any human willfully **meaning**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

PRIGOGINE also adds: "... the **phenomenon** of bifurcation is extremely general and ... there is a wide **variety** of solutions that can bifurcate: multiple **steady states**, **oscillating** solutions, propagating **waves**, etc. Also there could occur higher-order bifurcations" (1984, p.50).

It is by crossing a **critical value** in the **parameter space** that the **trajectory** becomes divided into two possible **trajectories**, corresponding to two different qualitative **behaviors**.

According to R.N. ADAMS "... a number of alternative further **paths**" is even possible (1988, p.66) and, at such "crossroads" any small **random effect** may lead to **nucleation** of new **structures**.

It thus becomes impossible to predict with perfect accuracy the future **behavior** of the system.

The **domain** of possible **behaviors** becomes discrete, and sudden **transitions** (i.e. "**catastrophes**") may occur from one **state** to another quite different one.

The first **bifurcation** signals the onset of **chaotic behavior**, proper of **non-conservative**, or **non-Hamiltonian systems**, also called **dissipative**.

The concept of bifurcation is a significant link between:

- the theory of **irreversible systems far from equilibrium** (i.e. **dissipative**)
- the mathematical theory of **catastrophes**
- the theory of **chaos**, or **topological dynamics**

According to S. WIGGINS such a **change** is a result of "qualitative **changes** that occur in the orbit **structure** of a dynamical system as the **parameters** on which the **dynamical system** depends are varied" (1988, p.62).

K.DE GREENE states: "A bifurcation is most generally the appearance of a new solution to reaction-diffusion equations at some **critical value**. Systems moving toward bifurcations reflect both **deterministic** and probabilistic features. These systems behave deterministically between bifurcation points; however, near bifurcation points, **fluctuations** are essential to **selection** of the **path** the system will follow. Such systems may be structurally **unstable** if arbitrary small **fluctuations** alter the mechanisms of **interaction** between system **elements**. Evolving **complex systems** show successive **instabilities** associated with successive bifurcations that produce increasing **coherence**" (1988, p.290).

0282

BIFURCATION AS AN IRREVERSIBLE PHENOMENON²⁾

I. PRIGOGINE and P.M. ALLEN write: "When bifurcation occurs, then **stability** of the existing **state** of the system breaks down, allowing the **amplification** of some small **random fluctuation** to occur and to carry the system off to one of the possible, new branches of solution".

And "... **nonlinear interactions** can give rise to bifurcating solutions of the phenomenological equations, such as those of chemical kinetics, for example, and this gives rise to new dynamic, coherent **structures**, which have been called **dissipative *structures**. However, even in **equilibrium systems**, bifurcating solutions can occur, but in such cases they correspond to the occurrence of an **equilibrium phase transition**" (1982, p.7).

According to F. HEYLIGHEN when a bifurcation takes place, pushing the system into one of several new **regimes**: "...the **process** is no longer predictable. We do not know which of the available **trajectories** the system will choose at the bifurcation point. The **process** becomes **stochastic**". (1989, p.366).

At a point of bifurcation the **process** becomes **divergent**. Thus bifurcations are antinomic to **equifinality**.

0283

BIFURCATION (Symmetry-breaking)²⁾

A bifurcation leading to the non-symmetric splitting of a rotating fluid as it solidifies.

The subject was introduced by H. POINCARÉ (1892, 1901) in relation to the study of rotating gravitating fluid masses in celestial mechanics. It seems that these were the very first examples of an incipient **chaotic behavior**

0284

BIFURCATIONS (Social)⁴⁾

E. LASZLO has proposed the following applications of the bifurcations **model** to societies. He makes a distinction among:

- **T bifurcations** "due to the destabilizing **effects** of technological innovations";
- **C bifurcations** "due to **instabilities** introduced by **conflicts** and conquests";
- **E bifurcations** "triggered by the internal **collapse** of the dominant institutions owing to mushrooming economic and social crises" (1987, p. 150).

LASZLO gives interesting examples of all of these bifurcation types, showing that the **model** is much more than a **metaphor**, or even an **analogy**, in social sciences.

0285

BIJECTIVE RELATION²⁾

A relation between two **sets** of **elements** such as any **element** of the first one corresponds to one and only one **element** of the second one.

Bijective relations are important in order to establish and verify a satisfactory relation between a **concrete system** and its **model**, or between general **models** derived from various **concrete systems**.

0286

BINARY CODE⁵⁾

A **code** which is used to express numbers on base 2, using 0's and 1's only.

Such a **code** permits the reduction of complex sequences of **decisions** to a succession of "yes/no" ones. It is based on **Boolean** logics and is perfectly fit for use in **digital computers**. It can be used in any type of **operations** corresponding to the third excluded logic.

0287

BINARY LOGIC

→ **LOGIC** (Binary)

0288

BINARY RELATIONS²⁾

Binary relations appear in **graphs** and **matrices**.

There are different types of binary relations, as follows:

- **reflexive**, by which a **node** is connected to itself through a **loop**
 - **symmetric**, by which two **nodes** are connected by two opposite **arcs** of the same value
 - **transitive**, by which a third or nth **node** is connected to the previous ones by an unbroken **path**
 - **antisymmetric**, where two **nodes** are connected by opposite **arcs** of unequal value
 - **equivalent**, if the connection is simultaneously reflexive, symmetric and transitive
 - **similar**, if the connection is simultaneously reflexive and symmetric
 - **ordered**, if the connection is simultaneously reflexive and transitive
- (After A. KAUFMANN, 1970, p.21-26).

This classification is helpful in order to distinguish more clearly different types of relations. The binary character of these relations is very convenient for computer **modeling**

0289

BINARY SIGNAL

→ **SIGNAL** (Binary)

0290

BIO-AMPLIFICATION^{1) - 5)}

The progressive concentration of chemical products through the pyramid of **living systems**.

A good example is the primary absorption of DDT or other toxic chemicals by the phytoplankton and their further concentration through the oceanic trophic sequence: small fishes, big fishes or penguins and other marine birds, and finally carnivorous marine mammals.

The possible effects for animal life in general are still ill known.

0291

BIOCENOSE⁵⁾

The living **community** of plants and animals in a **biotope**

0292

BIOCHEMICAL EVOLUTION⁵⁾

This subject was tackled by the belgian biochemist M. FLORKIN (1944)

While this technical work seems rather specialized, it has been important in showing the "unity in diversity" in the general **organization** of life in animals.

Florkin also considered, in his former "Introduction a la Biochimie Générale", biochemistry's relations with **biosphere** and the consequent **interrelations** of living beings to the biospherical **cycles**.

This research is probably still more significant today, after the deep alterations of the biosphere by man's activities.

0293

BIOCOMPUTATION⁵⁾

von FOERSTER biocomputation, in the words of W.R. WINBURN "... reveals how the **structure** of the nervous system and the **recursive** nature of **neural events** determine an **organizationally closed process** of **cognitive development**...

von FOERSTER explains how **autopoiesis** and **cognition** may operate in accordance with the mathematics of **recursive function** theory, in which an infinite series of **recursive operations** in a closed algebraic system develops stable **values** that produce themselves (i.e., **eigen values**, the German term for self-values) (1991, p.565).

0294

BIOCYBERNETICS: Its eight basic rules^{2) - 5)}

F. VESTER thus defines and comments the basic **rules** of biocybernetics:

"1. **Negative feedbacks** must predominate over positive ones.

... **Positive feedbacks** provoke **reinforcements**. Negative ones protect **stability** against **perturbations** and avoid **thresholds** overcrossings.

"2. Systems **functions** must be independent from **growth**.

... Energetic and material **flows** become constant in the long run. This limits the influence of **irreversibility** and uncontrolled crossings of **values limits**.

"3. The system should be **function** oriented, not product oriented.

... Resulting **variability** enhances **flexibility** and **accommodation**. The system becomes able to survive variable requirements.

"4. Use of available forces, according to the Jiu-Jitsu principle instead of boxing method.

... Outside **energy** is better used (**energy** cascades and chains), while internal **energy** is mainly used for steering. This enhances **self-regulation**.

"5. Multiple use of **functions**, organizational **structures** and products.

... This reduces **flows**, increases **integration** and reduces **energy**, **matter** and **information** expenditures.

"6. **Recycling**. Re-use through cyclical **processes** of **waste** and residual heat.

... Amalgamates **outputs**. When **flows** become **cyclically** organized, **irreversibilities** and **dependences** are restricted.

"7. **Symbiosis**. Reciprocal use through exchange and harmonious **coupling**.

... Favours limited runoffs and shorter transport lines. Diminishes **flows** and external **dependence**, while increasing internal **dependence**. Limits **energy** use.

"8. Biological **design** of products, **processes** and organizational **structures** through **feedbacks** planning with the **environment**.

... Takes **endogenous** and **exogenous rhythms** into account, as well as useful functional matches. Harmonizes the **system's dynamics**. Allows for the **integration** of new **elements**, in accordance with the eight basic **rules**" (Adapted from F. VESTER - 1983, p.82).

These basic **rules** could seemingly be extended to **groups** and social systems, as a groundwork for **sociocybernetics**.

0295

BIOLOGICS^{2) - 5)}

"A field of research intended... to establish super-additive **nonlinear** composition **rules** for the **elements** of **living systems**" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.160).

This field was introduced by H.von FOERSTER (1958, p.240-255), who spoke of "biological computers" and established the differences between the ways of internal **organization** of electronic computers and **living systems**.

In these, "...as the general case, the **function** "phi" of the **whole** exceeds the sum of the **functions** of the **parts**:

$$\Phi(x,y) > \Phi(x) + \Phi(y)$$

(BLAUBERG et al, p.160).

The subsequent development of biologics led to the concepts of **autopoiesis**, **self-reference**, **eigen-values** and **organizational closure**, and to a better **understanding** of **neural networks**.

More recently, it seems to open the way toward a still more general **understanding** of social **nets** and kinds of "social robotics" and highly **parallel** computing (**connection machines**).

0296

BIOLOGY (Relational)¹⁾⁵⁾

Organismic biology, as developed by Bertalanffy, Needham, Weiss, Woodger and others was one of the roots of systems theory, as a more general **transdisciplinary worldview**.

It was however not the only one. D. Gernert writes: "In the late 1920's. a pioneer of mathematical biology, Nicholas Rashevsky, set up mathematical **models** of specific biological **processes**, such as nerve excitation, cytokinesis, cardiovascular dynamics, central nervous **functions**, and many others. This was done with **mathematics** of that time...

"Later on, however, Rashevsky himself was more and more worried by doubts about the reach of his **models**, and looked for "a successful mathematical theory which would treat the integrated activities of the **organism** as a **whole**" (Rosen, 1994, p. 421). His endeavours led to what he called relational biology, as distinct from quantitative or metric biology. What really counts is no longer one or another **variable**, accessible to physical measurement, like blood pressure or electric potential at a certain spot, but the overall **structure**, which can be expressed, e.g., by a set of **organs** and the set of the relations between the **organs** (see e.g. Rashevsky, 1967) (quoted from D. Gernert, 2000, p. 157-58) Gernert adds: "Molecular biology, developmental biology and other fields require fundamental **patterns**-related **operations**: **pattern generation**, **pattern transfer**, **pattern recognition**, **pattern interpretation** and **patterns application** (Ibid.)

The same aspects became also apparent in **ecology** and in animal **ethology** and **zoo-semiotics**, as for example in the **interpretation** of biological molecules (pheromones, etc) as **signs** carrying **meanings** between animals, and even between plants and animals.

0297

BIOMATRIX⁵⁾

The global **network** of living beings (After G.G. JAROS, 1994, p.5-6)

The biomatrix is a **hierarchy** of many **levels**, all interconnected. JAROS considers the isolated study of any **part** (in his vocabulary: "**tel-eons**") of the **network** as quite difficult, in view that his theory corresponds mainly to the study of **processes**.

0298

BIOMORPHS²⁾

Graphical **structures** that represent, in a very simplified way, **processes** of **evolutionary transformations**.

R. DAWKINS (1986) introduced these curious **models** that, through **processes** of splitting and growing according to some **rules** prescribing the **behavior** of different "genes", can proceed from very simple to quite complex **forms**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0299

BIONICS⁵⁾

The science of **artifacts** or artificial systems whose **structure** and/or **operation** is imitated from natural systems.

It also includes the study of the natural **design of living systems** or their **parts**.

Bionics started with the **design** of architectural **structures** and, later on, of artificial limbs, for example. It is now progressing apace through the study of natural **processes** of **organization** and **regulation**. A. GIORDAN proposes the name of **physionics** for this extension of bionics (1996, p.81-6).

0300

BIOS¹⁾⁵⁾

A natural **process** mainly in **living systems** that continually creates novel and transient **patterns** (H. Sabelli, pers. comm.)

Sabelli develops the concept as follows:

"As unpredictability defines **chaos**, novelty defines bios" "Biotic patterns have been identified in time series of:

- heartbeat intervals
- economic indexes
- series generated by the process equation that formulates **process theory**

"Bios resembles natural processes and human **language** in continually generating new patterns. In contrast, an **attractor**, including **chaotic** attractors, is changeless-the more it changes, the more it stays the same. Bios is also characterized by: 1) **asymmetric** rather than symmetric statistical **distribution**, 2) multiple **fixed points**, 3) high self-correlation (PEARSON's **correlation**), 4) anti-persistence (Hurst exponent <0.5), 5) patterned wavelet and **recurrence** plots resembling those obtained with 1/f **noise**, and 6) ring patterns in complement plots. In contrast to **random** series, bios is characterized by determined novelty and determined **recurrences** rather than abundant recurrence and low **determination**."

Around this basic concept, Sabelli and his collaborators have developed important applications in medicine and psychiatry, establishing a much closer connection between physiological and psychological disorders.

Sabelli is attached to the Rush Hospital in Chicago.

0301

BIOSEMIOTICS¹⁾³⁾⁵⁾

The study of the origins of **meanings** as a problem of biology (K. Kull, 2000, p. 91)

"A new **field** which concerns itself with **signs** in biological systems, ranging from **communication** among animals to the individual **cells'** genetic **code** as a **sign** system of its own" (Cl. EMMECHE, 1994, p.126)

The field is also known as **Semiotic Biology**

The beginnings of Biosemiotics can be traced back to J.von UEXKULL (1928, 1934)

However, the subject lay dormant for many years. It is now reviving, specially with G. WITZANY in Austria (2000), M. BARBIERI, University of Ferrara, Italy, K. KULL, University of Tartu, Estonia and the "Cybernetics and Human knowing group" of S. BRIER, in Denmark.

The following statement by WITZANY, quoted by Kull (2000, p. 92) seems to clearly define the central idea of Biosemiotics: "...living nature is structured and organized in a **language-like** and communicative manner, i.e. that all **organisms**, including humans, are members of a global **community of communication**... Evolutionary **history** could then be understood as a developmental history of **interaction** semi-oses"

→ **Biosphere; Colony; Ecosphere; Ecosystem; Ecosystems dynamics; Ecosystemic relation; Evolution(Co); Gaia hypothesis; Information transmission; Stigmergy; Swarm; World Engine**

0302

BIOSOMA⁴⁾⁵⁾

The indissoluble **combination** resulting from the **interactions** between **biology**, society and **machines** (G. BUGLIARELLO, 1998, p.230)

BUGLIARELLO, who introduces this interesting concept, comments: "**Technology**, the **process** that human societies devised to produce and use **machines**, is in itself the quintessential biosoma" and "Despite the prevalence of such bio-socio-**machine** complexes, we rarely consider their broad implications. Nevertheless, our future depends on understanding the different characteristics, potentials and **pathologies** of the three **elements** of a biosoma and the opportunities that a well-guided **synergism** can offer".

The author adds: "Problems arise in a biosoma when there are imbalances among its **elements**... The social **element** of a biosoma responds slowly to innovations in the **machine element**. These frequently require new organizational **patterns**, new laws, the development of new **perceptions** or the evolution of new customs"

Moreover: "The human **element** of a biosoma is bound to commit **random** errors in **performance**, and it is powerfully affected by psychological factors" (p. 229-31)

0303

BIOSPHERE¹⁾

The global **space** occupied on our planet by **living systems** within their total **environment**.

The term "Biosphere" was introduced by the Russian geochemist Vladimir VERNADSKY (1863-1945) in 1926 (see 1929)

In 1935, A.G. TANSLEY introduced the closely related concept of "Ecosystem"

The biosphere is merely a "... thin covering of the planet that contains and sustains life" (UNESCO-UNEP, 1983, p.6)

The existence of the biosphere is the result of the ability of living beings to construct and maintain complex **structures** by **dissipating** electromagnetic **energy**, at the high **cost** of major global **entropy production**. However, it seems that globally, through what LOTKA called the **world engine**, this **process** tends to respect PRIGOGINE's **theorem of minimum entropy production**... save the puzzling fact that, at present, mankind seems to be violating this principle on a massive scale.

According to J. LOVELOCK, the biosphere is an **integrated system** wherein **energy**, mineral **elements** - gaseous, liquid and solid - and living beings find themselves enmeshed in a global **symbiosis** in continuous **evolution** through **time**. This is the so-called **GAIA hypothesis** (1979).

A deeper **understanding** of the numerous **symbiotic** exchanges within the biosphere seems to be an urgent condition of **survival** for mankind.

Recently, E. ODUM proposed a **parasitic model** of the **relation** of mankind with the biosphere (1997).

Such a **model** seems indeed close to the actual and present ways of man's **relations** with our planet. Possibly our challenge is now to shift from a **parasitic relation** at least to a **commensalist** one and, hopefully to a **symbiotic** one. In fact, the idea is not new: It was proposed (in 1935!) under the guise of an "**Interdependence** declaration" (between plants and animals - among them, men of course) and an "Ecological Constitution", by W.P. TAYLOR, at the time President of the American Society of Ecology.

...So many significant ideas lost in the mists of the past!

0304

BIOTOPE⁵⁾

"A small geographic unit occupied by a **community** of plants and/or animals and characterized by a high degree of uniformity in its main climate, soil and biotic conditions" (UNESCO-UNEP, 1983, p.7).

A sand desert, or a small island, or a lake are examples of biotopes as defined by UNESCO-UNEP lexikon.

As a rule the plant-animal **community** entertains **symbiotic relations** and fluctuates in relation to the **environmental** conditions.

0305

BISOCIATION³⁾

The supposed interlocking of two **matrixes**, or **frames** of thought, leading to creative ideas.

This concept was proposed by A. KOESTLER, as the sudden **association** of "two self-consistent, but habitually unconnected **frames of reference**". KOESTLER explains: "I have coined the term "bisociation" in order to make a **distinction** between the routine skills of thinking on a single "plane", as it were, and the creative act, which... always operates on more than one plane" (1964, p.35).

Bisociation is generally sudden and unexpected. Numerous examples are known in sciences and the arts.

Bisociation, as a **model**, is in fact an attempt to explain the way **analogies** (or even significant **metaphors**) suddenly crop up.

The concept seems also related to K. STEINBUCH's **learning matrixes**.

0306

BIT (= Binary digit)⁵⁾

"The unit of selective **information-content**... which determines a single **choice** between equiprobable alternatives" (D. MCKAY, 1969, p.172).

This unit of quantity of **information** is also sometimes called the HARTLEY, as this author studied **transmission of information** as early as 1928.

A bit represents a single yes/no **decision** and is the basic unit in **digital computers**.

The bit capacity of a **channel** is the number of bits transmissible per second (p.175).

0307

BLACK BOARD⁵⁾

A zone of common access in a **distributed artificial intelligence network** where **information** can be traded between autonomous **modules**.

E. BUCHBERGER describes it as the: "Global **data structure** which stores all the intermediate and final results in an **expert system**" He adds: "The blackboard is mostly **hierarchically** organized. Any **data** exchange between **programs** (or **knowledge** sources) ensues on the blackboard" (1987, p.29).

Another possible **communication** mode is by reciprocal sending of **messages** between the **modules**. In this case **criteria** of **channel availability** and **periodicity** must be established.

This, interestingly, seems a good **model** of the exchange of **information** in **human systems**: an example could be the electronic trade boards in stock markets, which **information**, furthermore, can be transmitted over electronic **networks**.

0308

BLACK BOX²⁾

"A box to which **inputs** are observed to lead and from which **outputs** are observed to emerge" (St. BEER, 1968, p.293).

The "black box" **model** has been - according to ASHBY - introduced by J.C. MAXWELL to "justify the building of functioning **descriptions** (in his case equations) that accounted for the observed **behavior** of some **phenomenon** when the workings of the **phenomenon** were not clearly visible" (R. GLANVILLE, 1982, p.1)

And "Briefly, a black box can be characterized as:

- a) being believed to be distinct
- b) having observable (and relatable) **inputs** and **outputs**
- c) being black (that is, opaque to the **observer**") (Ibid., p.1)

Of course, any black box is black for some specific observer, i.e. becomes a **construct** of the observer through his peculiar way of **observation**.

GLANVILLE, who discusses widely the black box model, adds that, after experimenting with the box, "what the observer has is a functional **description** that has worked in the past. That it will continue to do so is a pure article of faith: The black box regularity is an **assumption**" (Ibid, p.2).

However, when repeated **observations** produce similar results, this assumption is reinforced and "it is said that the black box has become white. The whiteness (as WIENER, 1948, asserts) is not a property of the box, but of the observer's **interaction** with it" (Ibid, p.4).

Viewed possibly from outside (by another observer), the interaction between the black box and the observer is, in fact, between two black boxes, and the whole system is thus a higher level black box.

In order to reach some **consensus** about a (tentative) conclusion we should thus clearly state our own observation **level**.

The black box can be either a concrete experimental **artifact**, or a conceptual **model**.

R. ESPEJO writes: "The black-box **construct** is a shorthand for the real world, that is, for the **transformations** actually taking place in it" (1988, p.140).

It however should never be forgotten that different **observers** may interpret the same black-box **behavior** in different ways (W. KARGL, 1991, p.577). The internal **organization** of this box is at the start of the experiment totally unknown. It must be conjectured by making hypotheses about the links between **inputs** and **outputs** and modifying these hypotheses as the experience is furthered.

St. BEER comments: "The reason why we contemplate a box having such odd properties, is that the more familiar box in which something is known about the internal **connectivity**, has its **variety** (already) **constrained**... Even if an arrangement having fairly high **variety** were chosen, the potential **variety** of all the other arrangements which could have been built in is

suppressed. But a black box is assumed to be able to take on any internal arrangement of **input-output connectivity** at all; it can therefore proliferate maximal **variety**" (Ibid.).

→ **Grey box**.

0309

BLACK BOX METHOD^{2) - 3)}

"A **strategy** for investigating a complex object without **knowledge** or assumptions about its internal make-up, **structure** or **parts**" (K. KRIPPENDORFF, 1986, p.7)

The general idea of this **method** is to send **inputs** into the system and to monitor the resulting **outputs**, making conjectures about the internal **processes** within the system that can explain how a specified **input** produces a specific **output**. In general, systems are "grey" boxes, i.e. **entities** about which at least something is known.

The black box method is widely applied in engineering, biology and other sciences, because of its **heuristic** value.

However, as stated by KRIPPENDORFF: "The **isomorphism** between the black box and its **model**, which the **method** aims to establish, does not imply **structural** correspondences between the two" (Ibid). One should thus be careful and not extract unwarranted conclusions from experiments that could be incomplete or ill interpreted.

0310

BLACK BOX OR BLACK ENGINE ?³⁾

J.L. LEMOIGNE proposed to dynamize the **black box model** (1977, p.99).

From the systemic viewpoint the **black box** does not merely possess one determined **state**. On the contrary it develops a series of successive **states**, as it possess a **diachronic structure**. Only by registering large series of **behaviors**, resulting from a great **variety** of **stimuli**, corresponding to very varied global **situations**, could we discover part or the **whole** of its internal **organization**.

This is why LEMOIGNE puts forth the concept of "black engine", which is of course implied in the **understanding** of the **black box model** by most cyberneticians and systemists.

0311

BLINDSPOTS³⁾

The non-**perception** of some aspects of **problem situations**.

H.von FOERSTER uses the example of the ocular blindspot as a **metaphor** for psychological and mental selective blindness. P. LEDINGTON has given a remarkable example of this anti-systemic disease (1992, p.57), but many others are well-known. The basic causes are the difficulties for specialists to **see** aspects of a **situa-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

tion outside their own field, their feeling of righteousness about their own way to tackle a problem and their tendency to mere technical patching up.

LEDINGTON observes that there is also a kind of communities blindness – through **subsumption** of individual and **groups** blindness – which does not allow them to face their problems in a coherent way.

G.de ZEEUW's "invisibility" and R.S. ACKOFF's fables and parables are closely related to the blindspots problem.

The elimination – or at least, **reduction**- of blindspots can be obtained through **conversation** among various **observers** who observe the same **situation**. In effect, each one observes or can observe the blindspots of the other observers and thus contribute to their detection

0312

BLOCKING MECHANISM¹⁾

In relation to the existence of **functional cycles**, J.von UEXKÜLL, as early as 1928, showed the presence in systems of mechanisms able to block functional **processes** when they could cross a **threshold of instability**.

He added that the blockage is absolute in the case of a critical **threshold** whose crossing would provoke the systems destruction. However, when the **process** leads to **fluctuations** within acceptable **limits**, the mechanism merely acts as a guideline (1979, p.164).

von UEXKÜLL's concept may be generalized, considering that any **function** in a **complex system** appears to be controlled by a **pyramid** of hierarchical blocking **mechanisms** at different **levels**.

→ **Slaving Principle**

0313

BOIDS²⁾⁵⁾

Computer **models** of birds used to study **flocking behavior** in real birds.

These "computer birds", designed by C.W. REYNOLDS, are assigned the following individual **rules of behavior**:

"1. Maintain a minimum distance to other **objects** (including other boids) in the **environment**.

"2. Seek to adjust speed according to the other boids in the immediate **vicinity**.

"3. Maintain the position in the **vicinity** of that **location** considered by the boid to be the center of the flock (the "center of gravity" of the other boids nearby)

"A migratory urge is built into the **model** and specified in terms of a global direction, ...to make sure that the flock does not remain in the **location** but continues forward"

These **rules** are sufficient to elicit collective **behavior** of the boids, as for instance avoid by suitable dispersal, obstacles introduced in the modeling **space** and thereafter reconstruct an ordered **flocking**. (C. EMMECHE, 1994, "Schools, Shoals, Swarms", p.89-90)

0314

BONDING MECHANISM (Inchoate)²⁾

The incipient or not yet perfected establishment of bonds between **elements**.

This concept is discussed by J. BRYANT (1991), p. 113-120) in relation with the progressively organizing **linkages** among **neurons** in the **brain**. He writes, about synaptic **links** between neurons: "We shall assume that (such) transient electrochemical states actually do occur when neurons fire; and we shall call them inchoate bonds, since they function in a matter similar to, and as prior conditions for the **growth** of a synaptic bond"(p.114)

Analogous **mechanisms** are probably active in any system developing the internal relational **organization** among its **elements**. It should be useful to discover their existence and characteristics in all **complex systems** in their formative **process**

The study of **globalization** processes in these terms could be useful

→ **Autogenetic system precursors; Engram; Memory;Parallel distributed Processing; Zero system**

0315

BOOLEAN ALGEBRA²⁾

The algebra corresponding to discrete (or finite) mathematics.

This algebra was introduced by the British mathematician and logician G. BOOLE in his book "An Investigation in the Laws of Thought" (1854)

J. WARFIELD resumes: "There are precisely two **constants** in Boolean algebra. They are 0 and 1. A Boolean **variable** *x* is an unknown that may take only the values of the constants, that is 0 or 1.

"The complement of 0 is 1, and the complement of 1 is 0. The complement of a Boolean **variable** *x* is written $\bar{x}$. It is also called the "negation of *x*" or may be read simply as "not *x*" (1989, p.208).

The parts of Boolean algebra which are relevant for systemics are "... **sets** and partitions, **orders** and partial orders, **binary relations** and **lattices**..., vectors, **matrices** and **digraphs**" (Ibid)

WARFIELD develops these aspects and gives references (p.208-84). He developed his theory in notably systemic terms.

0316

BOOLEAN formulation of a network²⁾

Let us suppose *N* Boolean **automata** (able to transmit only the values 0 or 1) that are connected in a network. At any moment *t*, each automaton has a value 0 or 1, which is function of the value of a number of other automata in the network at the instant *t-1*. In such a network there are 2^N possible **configurations** (i.e. 10^{30} for a network of 10 automata with all their potential connections) (adapted from H. ZWIRN, 2002, p. 54)

As it is not possible to consider simultaneously the behavior of many automata (as it depends from the others and that **communication** is neither **isochronic**, nor isospatial, the behavior of the network is difficult (practically impossible) to forecast. However"...as the number of possible configurations is limited, the network's global behavior must be cyclical... However, the **cycle** is necessarily very long and the network's dynamics will seem chaotic" (Ibid)

0317

BOOLEAN FUNCTION²⁾

"A logical switching **rule** which specifies the **activity** of a **variable** in response to all the possible combinations of **activities** in the **input variables**" (St. KAUFFMAN, 1993, p.65).

St. KAUFFMAN writes: "The Boolean function specifies for each possible combination of current **activities** of the **input variables**, the **activity** of the regulated **variable** at the next moment. For example, an **element** with two **inputs** might be active at the next moment if either one or the other or both **inputs** are active at the current moment" (1993, p.188).

There are two Boolean functions:

- The **OR function**, "which says that a **variable** will be active if any of its **inputs variables** is active" (Ibid).
- The **AND function**, which "declares that a **variable** will become active only if all its **inputs** are currently active" (Ibid.).

These very simple **rules** were enounced originally by George BOOLE and are of cardinal importance for any study of **networks**.

0318

BOOLEAN NETWORK²⁾

"A system of **binary variables**, each with two possible **states of activity** (on and off), coupled to one another such that the **activity** of each **element** is governed by the prior activity of some **elements** according to a **Boolean switching function**" (St. KAUFFMAN, 1993, p.182).

St. KAUFFMAN writes: "In a Boolean network, each **variable** is regulated by others that serve as **inputs**. The dynamic **behavior** of each **variable** – that is, whether it will be on or off at the next moment – is governed by a logical

switching **rule** called a **Boolean function**" (see above) "The **function** specifies the **activity** of a **variable** in response to all possible combinations of **activities** in the **input variables**... One can calculate how many **Boolean functions** could conceivably apply to any **binary element** in a **network**. If a **binary element** has K **inputs**, then there are 2^K possible combinations of **inputs** it could receive. For each combination, either an active or inactive result must be specified. Therefore, there are 2 to the 2^K power possible **Boolean switching rules** for that **element**" (1991, p.67)

Many, if not all social **interrelations** in the most general sense seem to be amenable to **network modelling** in the Boolean sense as for example: neural **nets** in the **brain**, **nets** in **connection machines**, social interactions in **groups** and, possibly in the future **networks of robots** (see for example R. BROOKS, 1991)

0319

BOOLEAN NK NETWORK (Autonomous random)²⁾

A Boolean network whose **inputs** are all of **endogenous** origin.

Such networks are used by St. KAUFFMAN for the study of biological systems (1991), but have obviously a potentially wider field of applications, as for example in **languages** and in natural or artificial social systems.

The concept also seems to be related to **autopoiesis**, **organizational closure** and **autocatalytic hypercycles**. In KAUFFMAN's words: "A critical feature of random Boolean networks is that they have a finite number of **states**. A system must therefore eventually reenter a **state** that it has previously encountered... It will consequently **cycle** repeatedly through the same **states**" (p.66)

For a full development of the NK model, see reference.

0320

BOTTOM UP¹⁾

The progressive **self organizing mode** of a system or **model** composed of numerous **elements** each of which endowed with limited elementary capabilities and able to interact in a not absolutely determined way.

This notion has been described as follows by J. ERCEAU and J. FERBER in their study on **Distributed Artificial Intelligence**:

"**Agents** endowed with an elementary **behavior** potential, of the type **stimulus-action** (for example: to be attracted by a **signal**) are able to interact. From these local **interactions**, **structures** arise, which appear as globally organized. "Intelligence" thus emerges from the **interactions** of a great number of **agents**, individually devoid of "intelligence". An **analogy** sometimes used here is the anthill, the termite-hill or the beehive" (1991, p.755)

Furthermore: "The elementary units have thus specific **behaviors**, which do not necessarily coincide with **subfunctions** of the wanted global **function**. This will emerge from the **interactions** among elementary units.

"...In the bottom-up approach, the system organizes itself to react in an adequate fashion in every case, from which its **flexibility** results. Furthermore, a breakdown in some unit does not impair the global working of the **whole**, thus conferring its robustness to the system" (Ibid).

This **description** seems to fit even very complex **social systems** (i.e. systems including a very great number of **elements** capable of undergoing a very considerable number of **interactions**). As well as to societies of insects, it can probably be extended to societies of **automata**, to human societies and, possibly to societies of neurons in the **brain**.

As to **models**, for instance in **systems dynamics**, the bottom up procedure insists on starting with complete **models** of all the separate subsectors. D. MEADOWS et al state that these "should be carefully estimated, tested, elaborated and explored, so that one understands and has confidence in each part of the **model** before they are fitted together" (1982, p.274)

Still, in the case of the **Systems Dynamics model**, the **process** of fitting together, far from spontaneous, is decided by the modelizer and thus more or less depends on her/his subjective views.

The "bottom up" approach should not be exclusive of the "**top-down**" one. Both are in fact complementary, as expressed by Cl. PAHL-WOSTL (1993): "...the **dichotomy** between **top-down** and bottom-up **control** converges to a mutual and inseparable **dependence** on both factors. Neither a purely **reductionist** approach nor a merely **holistic** perspective is sufficient to encompass the intrinsic nature of the systems **behavior**"

0321

BOUNDARIES of a PROBLEM^{1) - 3)}

According to St. BEER, determining the boundaries of a problem "is the most difficult problem in **operational research**". He adds: "In practice the scientist needs to enlarge the scope of his study in every dimension until the factors he is bringing in seem to make no tangible difference to the answers he is getting" (1968, p.53)

BEER's comment could very well be extended to the whole research on **complex systems**.

Furthermore, we should never forget that the accuracy of the definitions of boundaries depends on the perceptive competence of the **observer**: what is tangible? to whom?

See "cognitive **blindspot**", "**invisibility**", "**underconceptualization**"

0322

BOUNDARY^{1) - 3)}

"The **subsystem** at the perimeter of a system that holds together the **components** which make up the system, protects them from **environmental stresses**, and excludes or permits admission to various sorts of **matter-energy** and **information**"

This is J. MILLER's definition in his list of the **20 critical subsystems** of any system (1978, p.3)

In B. BANATHY's words: "The boundaries of a system delimit the system **space** and set aside from the **environment** all those entities that make up the system" (1973, p.85)

K. BAUSCH describes boundaries as the "**parametric** conditions that delimits and define a system and set it apart from its **environment**" (Glossary - Personal communication)

The concept of boundary is basically ambiguous, in two different ways.

First, the boundary separates the system from its **environment** by defining what is inside and what is outside the system. In some cases however, it is difficult to distinguish precisely if some **elements** of the boundary belong to the system or to its **environment**... or to both.

Besides, the boundary does not define an absolute enclosure. It allows some specific **inputs** and **outputs** and bars others. It is selectively permeable.

In L. CARLSON-SABELLI and H. SABELLI's words: "Boundaries, when they exist, are **interphases** where **opposites** coexist, neither sharply delimited as in logic, nor simply gradual **transitions**, but actual areas of interchange and/or **conflict**, as illustrated by cellular **membranes**, and by national boundaries. The **basins** relative to two **attractors**, for instance, can penetrate each other in a manner which is **topologically** very complicated, rendering the outcome undetermined" (1992, p.681).

Furthermore, the boundary may be open or closed, in relation to the circumstances which affect the system and its **environment**.

T.F.H. ALLEN and T.B. STARR (1982, p.262) define the boundary as "a **distinction** made by an **observer**" and add: "Artificial boundaries are drawn arbitrarily and haphazardly. Natural boundaries are still arbitrary, but tend to be robust under **transformation**. That is, natural boundaries coincide for many distinct **criteria**".

Quoting G.H. GOODE and R.E. MACALL, G. P. SHCHEDROVITZKY writes "... boundaries pass over broad vague territories and the search for their precise position would elicit large but fruitless controversies" (1966, p.35)

These difficulties move G. WEINBERG to write: "**Interface**" is a more useful word than "boundary", for it reminds us to pay attention to the **connection** and not just the separation between system and **environment**" (1975, p.147)

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

Boundaries of physical systems are at the atomic or molecular **level**. In **living systems** they become organized as permeable **membranes**. In an **organization** they can be material enclosures as well as the **behavioral** result of abstract **criteria** of membership.

0323

BOUNDARY CONDITIONS^{2) - 4)}

"...a **set** of supplementary **constraints** that the solutions of differential equations must satisfy at all times" (T.F. ALLEN and T.B. STARR, 1982, p.262).

It appears from the context that these authors understand that each **set** of boundary conditions corresponds to a typical **hierarchical level** (p.44).

As stated by H. HAKEN, boundary conditions can be **periodic** (1983, p.269). Consequently, there are specific boundary **variables** which affect boundary conditions.

J. PLATT writes: "The surface may be taken as passing through a family of points where some **parameter** such as "**interaction-density**" has a maximum **gradient**" (1969, p.201-214).

Furthermore... "The boundary-surface for one property (such as heat-**flows**) will tend to coincide with the boundary surfaces for many other properties (such as blood **flow**, **sensors** endings, physical **density**, and so on) because the surfaces are mutually-reinforcing".

And... "All **gradients** and **flows** in the **region** very near the boundary will tend to be either parallel or perpendicular to the boundary... Evidently in the **region** close to a boundary the strong-**coupling interactions** within the systems are parallel to the boundary while the weaker-**coupling interactions** between the system and the larger **super-system** flow in and cut perpendicular to the boundary" (Ibid).

All this obviously applies to boundary conditions in **social systems**, as for example beehives, anthills, business companies or nations.

A very important observation by I. PRIGOGINE et al. is that: "A sufficiently small system will always be dominated by the boundary conditions – the conditions imposed at the walls of the vessel (note: the authors are referring in this specific case to a chemical reaction. Similar effects are however present whenever boundaries are proportionally very important in relation to surface and volume)." In order for the **non-linearities** to be able to lead to a **choice** between various possible solutions, it is necessary to go beyond some **critical spatial dimensions**. Only then can the system acquire a degree of **autonomy** with respect to the outside world" (1975, p.31). This is because: "In the case of small-size **fluctuations**, boundary effects will dominate and **fluctuations** will regress" (Ibid, p.43).

This aspect is probably the most basic explanation of the universal tendency of systems – natural or artificial – to grow in **size**, at least up to some critical **limit** where the effects of big **size** become preponderantly negative.

Boundary conditions are not necessarily constant. A.S. IBERALL states: "... if boundary conditions of a nonconstant nature are maintained, the system may find a **process** which is either in **steady state** or which is dynamically fluctuating... It has begun to be realized that **fluctuations** and turnover are necessary conditions for the maintenance of **form** (See e.g. the work of PRIGOGINE, KATCHALSKY, MOROWITZ, PATTEE, IBERALL, ZHABOTINSKY)" (1973, p.5).

Such **concepts** were developed as early as 1942 by the French engineer Ch LAVILLE in his theory of **vortexes**.

0324

BOUNDARY (Elusive)²⁾

Fractal boundaries are infinitely complex and seem to dissolve as we try to pin them down more precisely.

This is undoubtedly a feature of existing **complex systems**, but then only up to the point where the **elements** of the boundary dissolve at a lower **scale** in some other type of lesser **elements**.

However, the mathematical **models**, especially their graphic representations, are quite useful to visualize the elusiveness of boundaries, which means that any boundary **element** is simultaneously within the system and within its **environment** (or within neither).

WEIERSTRASS function expresses this characteristic through the impossibility to differentiate for any **value** of the **function** (i.e. to draw a tangent to any part of the curve).

The same principle applies to every **fractal**.

0325

BOUNDARY OF EQUAL ADVANTAGE^{1) - 2) - 4)}

In K. BOULDING's words: "... any **organization** in competition with others will find that its advantage in the **interaction** diminishes as it goes away from some kind of "home base", so that at some point the advantages of any further expansion fall to zero".

BOULDING adds: "... the concept could easily be generalized. It is these boundaries of equal advantage which really define the **niches** of an **ecological system**" (1972, p.69-70).

The respective boundary of equal advantage tends to be more or less geometrically regular for competing or **cooperating** systems, as shown by W. CHRISTALLER and A. LÖSCH (see **hexagonal space filling**).

This seems to be a rather general result of **structuration by dissipation**.

It is also probably related to a problem of length of **lines of communication**, as the distance from the center of the system increases: the possible expansion of political or economic systems must submit to BOULDING's boundaries of equal advantage.

0326

BOUNDARY REGULATION^{1) - 2)}

No boundary is ever absolutely closed, nor completely open. It depends on the **energy flow**, as noted by R.N. ADAMS, in accordance with LOTKA's **Principle of maximum energy flow**: "The distinctiveness and **stability** of the boundaries of a **dissipative process** vary directly with the tendency of that **process** to seek a minimum **dissipation rate**, inversely with its tendency to maximize **energy flux**" (1988, p.149).

As to the **autonomy** of the system it depends at least partly on its ability to close or open its boundary for the purpose of maintaining its **dynamic stability** by regulating its **inputs** and **outputs of energy**.

The study of a variety of systems shows that boundary regulation is partly automatic (by **reflexes**) and partly voluntary. Furthermore the deliberate part of **regulation** grows steadily with the **complexity** through the evolutive **scale** of systems.

As **dynamic stability** results generally from the **cyclical** or **hypercyclical** succession of **states**, boundary regulation depends on the **knowledge** the system has of its own **states**, past, present and possible futures. The heightened **predictability** aptitude in highly **complex systems** goes matched with the increase of the **feedforward** (i.e. willful) capacity for **regulation** of their boundary conditions.

0327

BRAIN^{3) - 5)}

St. BEER described the brain in cybernetic terms as follows: "We have in the cranium a slightly alkaline three-pound electrochemical computer running on glucose at about 25 watts. This computer contains some ten thousand million (that's 10^{10}) logical **elements** called **neurons**, operating on a basic **scanning rhythm** of ten **cycles** per second. Then this is a **high-variety dynamic system** all right; but it really *is* finite. It follows from ASHBY's law that we can recognize **patterns** up to a certain **limit**, and not beyond. Thus if something is going on that involves a higher **variety** than the brain commands, we shall not recognize what it is. This is the old **constraint of requisite variety**" (1974, p.58).

BEER adds the following: "About a quart of blood (about one seventh of the circulation) flows through the brain every minute, and is heated about one degree Fahrenheit. That takes about 25 watts.

"The resting **state** of the brain, called the **alpha state**, is characterized by the **alpha rhythm**, which tends to be **stable** at around **ten cycles**" (p.67).

Of course, in 1974, research on **networks** and **connection machines** was just starting. The **analogies** between the brain and the computer (**digital** or **parallel**, or both?) surely needs still more careful scrutiny.

From another angle, related to the general **organization** of the brain, it would seem that it is at the same time localized (with specific perceptive and active areas), distributed (even a seemingly global **function**, as for instance sight, is the global result of a **synchronic synthesis** of distinct **perceptions** of **limits**, **position**, shape, motion, depth, colors, etc.)... and **hierarchical**, in the sense that, admitting the **modular** character of brain **organization**, brain works in a coordinated way (Philippe LAMBERT on Xavier SERON's cognitive neuropsychology - 1999, p.39-43 - Hemai PARTHASARATHY, 1999, p.29-31).

However "**hierarchical**" does not imply an all powerful and precisely localized organizer. It seems to respond to a kind of **chaotic determinism** through multiple **simultaneous** neuronal **interactions**, within diffuse **limits**, leading to **autopoiesis**

This could better explain **creativity**, **learning**, and also partial readaptation after some disability (as a stroke, for example).

→ **Algorithm (Back propagation); Algorithm (Framing); Algorithm (Iterative refinement); Algorithmization by selection; Information; Nervous system and brain, Memory (Distributed); Taxon memory**

0328

BRAIN and ENVIRONMENT^{1) - 3)}

... or the macrocosm within the microcosm.

According to V.I. KREMYANSKIY: "The brain first developed mainly as an organ of internal **interconnexion**, and then primarily as an organ of **interconnexion** with the **environment**" (1969, 125-46).

In fact, it seems probable that both developments have been simultaneous and complementary all along **evolution**, by a kind of alternating **process of reinforcement**, in relation to ASHBY's **Law of Requisite Variety**.

KREMYANSKIY adds: "This augmented the **dependence** of the **organism** on far more distant and complex **events** in the **environment** (with the development of the **organs of perception** and systems of **receptors**) (p.141).

Man has been speeding up this movement during the last centuries, with the **emergence** of more numerous and complex artificial **means of perception** and interpretation.

However, admitting that the enhanced presence of the **environment** under the guise of **representations** within the brain increases **dependence** it also increases the capacity to handle it, which of course brings forth new hazards.

0329

BRAIN CIRCUITS¹⁾⁵⁾

C. KOCH and G. LAURENT write: "Brain **circuits** are not **Boolean networks**, where **connectivity** is everything. They are not made of static, **linear neurons**, **isotropic nets**, or constant **connection weights**.... A more realistic accounting of the dynamic nature of neuronal ensembles and their nonrandom, inhomogeneous **connectivity topologies** has been incorporated by TONONI and his colleagues into a formal definition of "neuronal complexity" using concepts drawn from **information theory**. These concepts express the degree of **interactions** between **elements** of a neuronal **population**... **Complexity** will be high if a large number of subassemblies of varied sizes can be formed within the population" (1999, p.97).

Further on they add: "The standard **von NEUMANN** computer **architecture** enforces a strict separation between **memory** and **computation**. **Software** and **hardware**, which can be easily separated in a **computer**, are completely interwoven in brains... Furthermore, brains wire themselves up during **development** as well as during adult life, by modifying, updating, replacing **connections**, and even in some circuits by generating new **neurons**. While brains do indeed perform something akin to **information processing**, they differ profoundly from any existing computer in the scale of their intrinsic structural and dynamic **complexity**" (Ibid, p.98)

As stated by the authors, much work will still be needed to reach a better understanding of brain circuits.

→ **Synaptic weights**

0330

BRAIN - EYE LAW³⁾

This law has been proposed by G. WEINBERG in the following complementary form:

"To a certain extent, mental power can compensate for observational weakness;

"To a certain extent, observational power can compensate for mental weakness" (1975, p.96).

The first leg of this law is a result of the existence of conceptual **paradigms** and tested **models** and **methods**, accumulated through **learning**. **Observation** conversely, lead to a renewal of **viewpoints**, eventually conducive to a renewal of abstract **frames**.

0331

BRAIN: its organization¹⁾⁵⁾

The main parts of the brain are the following (for locations see fig.)

The definitions are from J. ECCLES (J.E.)(1977), or from the American Heritage Dictionary (AHD), (1978 ed.)

- Archicortex: the ancient part of the cerebral cortex; it includes the **hippocampus** (J.E. p. 234)
 - Cerebellum: the brain structure responsible for **regulation** and **coordination** of complex voluntary movements (AHD, p. 219)
 - Cerebral cortex: the extensive outer layer of gray tissue of the cerebral hemispheres, largely responsible for higher nervous functions
 - Cerebro-cerebellar pathways: the complex pathways linking the cerebral cortex and the cerebellum in both directions (J.E. p. 234)
 - Cerebrum: the main **structure** of the brain occupying most of the cranial cavity and divided into two cerebral hemispheres (AHD, p. 219)
 - Corpus callosum: the tract of nerve fibers connecting the cerebral hemispheres (J.E. p. 235)
 - Hippocampus: one of two ridges along each lateral ventricle of the brain (AHD, p. 624)
 - Hypothalamus: a deep lying part of the cerebral cortex, concerned in visceral control, f. ex. in relation to temperature, salt, water, food, endocrines, and mood (J.E. p. 238)
 - Medulla oblongata: the nervous tissue at the bottom of the brain that controls respiration, circulation and certain other bodily functions (AHD, p. 816)
 - Neo-cortex: the most recently developed part of the cerebral cortex, composing the cerebral hemispheres (J.E., p. 236) The neo-cortex includes an enormous array of interconnected neurons
 - Thalamus: the massive collection of nerve cells deep to the cerebral cortex, in part concerned with transmission of cutaneous sense to the cerebrum.
 - Ventricle: a small anatomical cavity in the brain (AHD, p.1421)
- A part of the thalamus (called ventrolateral) is specially concerned by the transmission from the cerebrum to the cerebellum (J.E. p. 243)
- This is of course a very simplified and sketchy description of the brain's structures.
- For much better **information** see f. ex. J. ECCLES (1978), J.Z. YOUNG (1978) here also used, or some more recent work, as for ex. R. CARTER (1998)

0332

BRAIN METAPHOR³⁾

As the **hypercomplex system** that it is, the brain is not yet fully understood. This is probably why it has been extensively used as a meta-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

phor for different concepts of **regulating** and **deciding** devices. The **hierarchical** brain metaphor extols the brain as the all powerful chief **controller** and **commander**, who should know and decide about everything.

Another and newer metaphor is the brain as a **learning** and adaptable **network** of **elements**. This seems to be a more adequate **analogy**, but the unifying and regulating powers of **networks** should not be forgotten. It is quite possible that future research into brain physiology could lead us to a still different metaphor or **analogy**, not necessarily incompatible with the existing ones.

Our metaphors should not blind us to some other important facts, as for instance the necessary **connections** of the brain (and other **learning-regulating-deciding** devices) with other critical **subsystems** and their significance.

0333

BRAIN (Triune)⁵⁾

A three levels model of the brain.

This **concept** of a multilevel **organization** of the brain as a **complex system** was developed by P. Mac LEAN, as quoted by A.S. IBERALL: "At its base lies the reptilian brain, in which one might say the **routines** or rituals of higher forms of life are governed and programmed. Surrounding that **structure** is the paleomammalian brain, the limbic **structure**, sometimes referred to as the older "smell" brain. Out of this the governing of the world originating from smell, the worlds of food and sex and aggression are intermingled (and sometimes confused). Finally, at the top emerges the neomammalian brain, the brain of sight, the primate brain, the brain of **cognition** and **language**, and coordination of **language**... What is characteristic of the neocortex is its rapid **response**, particularly to sensory **signals**. It programs at the millisecond **level**. It devotes a considerable part of its capacity to handling optical **signals**" (1975, p.21).

This **model** of the globally integrated brain has also been considerably developed by the French physiologist H. LABORIT (1954 and 1970).

0334

BRAIN-COMPUTER ANALOGY³⁾

It could be said that the superficial analogy between brain and computer which filled the pages of so many popular magazines has considerably obscured the issue of comparison of **artificial** as compared to natural **intelligence**.

Only the introduction of some "deus ex machina" would permit us to sustain such superficial analogy as for example in this statement by N.A. COULTER Jr. "Intelligence may be

defined as the **set** of **software programs** which enable the Supervisor (or Ego) (sic) to acquire, create, and execute application **programs**" (!) (1976, p.36).

Curiously enough COULTER himself adds: "... the self-determinism of brains is one fundamental difference between brains and computers"... but he immediately relapses again into the idea that these self-determined brains depend on "the consent of its Supervisor - Ego" to be "programmed" Where could such a "Supervisor" be located?

More recently, M. BODEN makes, from a different standpoint, the following criticism of the **analogy**: "... current **neural-network models**, for all their likeness to the brain, are significantly unlike brains too. For instance, nearly all involve two-way **connections**, whereas brain-cells send **messages** in one direction only. Any one unit is directly connected to only a few others, whereas the lacy branches of a given neuron usually abut to many hundred of **cells**. **Computer models** contain no **analogue** of the neurochemicals that diffuse widely through the brain. Further, neuro-scientists still know very little in detail about what computations are carried-out by brain-cells, and how" (1990, p.131). BODEN admits however that: "Certainly, the brain is a **connectionist** system" (Ibid).

Somehow, the brain is probably working simultaneously in **parallel** and sequentially, a "trick" that computers have just started to learn.

0335

BRAINSTORMING^{4) - 5)}

A mental exploration technique seeking new ideas through **unconstrained** conceptual **associations**.

Brainstorming tends to break rigid **reference frames** and, using coincidence, open the way to **serendipity** and discovery. It is a collective technique, used by groups interested in considering a **situation** and aiming at producing as many as possible new and creative ideas. It avoids critical stances as inhibitory to **creativity**. On the contrary, it encourages free-wheeling imagination, unfettered by inhibiting, authoritative or logical **constraints**. Its nature is systemic, since it helps to discover and explore hidden **interrelations** in **complex situations**.

The technique, quite popular during the fifties, is now nearly forgotten. It should possibly be reconsidered in more systemic terms, as it can be very useful in **decision making** on a wider **understanding** basis. See for example J. WARFIELD (1994b).

0336

BRANCHING²⁾

A graphical way to represent **hierarchical organization** in **space** or **bifurcating evolution** in **time**.

Branching as a **model** started from the "tree" **metaphor**. But a real tree is no **metaphor** and its main and secondary branches represent stages in its **growth**. Besides, its roots are also branching.

Of course, **organizations** where one commander or manager has **control** over 10 executive officers, each of whom in his turn commands and/or oversees a large group of people do exist, and can be represented by a branching **diagram**. So is a sequence of various simultaneous **operations**, modelled in a **flow graph** in **time**.

Branching thus corresponds to a well specified type of **order** within systems and/or **processes**. It is now formally incorporated in **theory of graphs**

0337

BRANE¹⁾

This shortened neologism for "membrane" has been introduced recently by some authors. Its usefulness remains to be established, specially as an intended generalization.

→ **Membrane**

0338

BREAKDOWN¹⁾

The structural disintegration or functional disruption of a system or **subsystem**.

M. BUNGE distinguishes: "If **integration** fails the system undergoes *structural breakdown*. On the other hand **coordination** concerns the **relation** among either **components** of **functions** resulting in functional **maintenance**. If **coordination** fails the system undergoes *functional breakdown*. There can be **integration** without **coordination** but not conversely. A complex **machine** out of kilter is integrated but not coordinated. On the other hand **organisms** are coordinated and a *fortiori* integrated as long as they live (1979, p.38).

While **machines** can be sometimes repaired, breakdown in **organisms** and **sociosystems** is generally **irreversible**.

0339

BREAKDOWN TIME²⁾

The **time limit** after which a system submitted to **wear** finally gets out of order or is destroyed.

The subject has been reconsidered recently by P. WINIWARTER and C. CEMPEL (1992, p.9-34), according to whom: "...the breakdown time is determined by the internal **structure** of the system and the way of **energy dissipation** inside the system" (p.25). Furthermore: "Every type of **symptoms** of **wear** approaches infinite **value** asymptotically at the **vicinity** of the breakdown time" (p.27).

Living systems, as well as artificially constructed ones have each a more or less characteristic breakdown time.

0340

BREMERMANN's LIMIT^{3) - 5)}

"No **data** processing system, whether artificial or living can compute more than 2×10^{47} **bits** per second and per gram of its mass" (as stated by K. KRIPPENDORFF, 1986, p.8).

G. KLIR writes: "Using the limit of **information processing** obtained for one gram of mass and one second of **processing time**, BREMERMANN then calculates the total number of **bits** processed by an hypothetical computer the size of the Earth within a **time period** equal to the estimated age of the Earth... This imaginary computer would not be able to **process** more than 2.56×10^{92} bits, or when rounding up 10^{93} bits. This last number 10^{93} is usually referred to as BREMERMANN's limit and **problems** that require processing more than 10^{93} bits of **information** are called transcomputational **problems**" (1993, p.44-5)

KLIR adds: "The problem of transcomputationality arises in various **contexts**. One of them is **pattern recognition**... Another **context**... is the area of testing large-scale integrated **digital circuits**". As a result, we need a "science of simplification" to reduce the **problems** of **complex systems** to a manageable size. This is one of the basic aims of **systemics**."

K. KRIPPENDORFF writes that the limit "refers to a self-contained system where the power supply is included in the total mass and where computation is defined as the **transmission** of **information** over one or more **channels** within the system. Recognizing that computation requires **energy** for changing physical **markers** and for recognizing such **changes** in subsequent steps, the limit is obtained from EINSTEIN's relation between **energy** and **matter**, $E=mc^2$, and HEISENBERG's **uncertainty principle**, which specifies the inaccuracy or **noise** in the **measurement** of **energy**" (1986, p.8).

For a suggestive development about "Everything material stops at 10^{100} " see W. ROSS ASHBY (1974, 166-9).

0341

BROWNIAN MOTION^{3) - 5)}

The **random** motion at microscopic **level** of particles suspended in a liquid or a gas.

As stated by P. DAVIES: "Brownian motion is the archetypical, **random** unpredictable **process**. Yet, so the argument ran, if we could follow in detail the **activities** of all the individual molecules involved, Brownian motion would be every bit as predictable and **deterministic** as clockwork. The apparent **random** motion of the Brownian particle is attributed solely to the lack of **information** about the myriads of participat-

ing molecules, arising from the fact that our senses are too coarse to permit detailed **observation** at the molecular **level**" (1990, p.49).

However: "Two major developments of the 20th century have... put paid to the idea of a clockwork universe" (Ibid).

The first was quantum mechanics which introduced **indeterminacy** at the physical micro-level as well as in relation to our possibility of **observation**. And the second one is **chaos** which, while still somehow **deterministic**, rapidly makes even very simple systems fairly **unpredictable**.

Thus, **determinism** cannot be polarly opposed to **randomness**, nor is **unpredictability** simply a result of our imperfect **perceptions**.

0342

BROWNIAN MOTION²⁾

A **Brownian motion** affected by some **constraints**, not sufficient to bring about full **deterministic behavior**.

This **concept** has been introduced by the French biologist P. VENDRYES (1942).

This author gives various examples. One is the register - by himself - of a Parisian taxi driver, who showed the following absolute or relative - **constraints** upon passengers instructions, or whims:

- remain within the **limits** of Paris municipality
- respect one way traffic **signs** and traffic lights
- follow some obliged routes for public transport
- occasional or more or less permanent diversions due to public works
- existence of some focal and thus more frequently asked for destinations: museums, famous monuments, railway stations, hospitals, etc.

A similar **model** was introduced by W.R. ASHBY in 1956 under the guise of **Markov chains** and **transitions probabilities matrixes** - with some quite entertaining examples (1956, Ch.9).

0343

BRUSSELATOR^{2) - 5)}

A general **model** for **cross-catalytic reaction cycles**.

The Brusselator **model** has been created by I. PRIGOGINE's **thermodynamics** study group in Brussels, "as a perfectly acceptable model for the study of cooperative **processes** in chemical kinetics. It plays somewhat the same role as such models as the harmonic **oscillator**..." (G. NICOLIS & I. PRIGOGINE, 1977, p.94). It consists of the following (very simplified) steps:

1. $A = X$
2. $B + X = Y + D$
3. $2X + Y = 3X$
4. $X = E$

X and Y are intermediate molecules in a global sequence through which A and B become D and E. The Brusselator is thus a very fundamental **transformation cycle**. For accurate description and insights, see reference.

0344

BUFFER⁵⁾

A device introduced into a **communication** system to allow asynchronous **communication**.

L. BRIM comments: "A buffer preserves **message** sequences. The buffer discipline is as follows:

- The **sender** may always send a **message**
- The **receiver** may always receive a **message**, provided the **medium** is not empty
- The order of receiving **messages** is equal to the order of sending **messages**" (1992, p.135).

Buffers allow for serialized and ordered **communication**, avoids bottlenecks and, to some extent, **overloads** in **communication channels**.

0345

BUFFER COMPARTMENT¹⁾

"A **part** of a system which acts as a reservoir for incoming **energy**, **matter**, or **information** such that the **inputs** enter the rest of the system with smoothed and averaged characteristics" (T.F.H. ALLEN & T.B. STARR, 1982, p. 263).

The quantities of **energy**, **matter**, or **information** stored in the buffer compartment are at the free disposal of the system. They can be used by **regulatory subsystems** when needed. This permits a **range** of differential **responses** in a changing **environment**, an adaptive **mechanism** sometimes called buffering, and it also opposes wide structural destruction.

0346

BUTTERFLY (LORENZ)^{1) - 2)}

A **chaotic attractor** whose graphical **representation** is similar to butterfly wings.

This **attractor** was discovered by the American meteorologist E. LORENZ. It graphicates the **turbulent sequences** of meteorological variations, submitted to the **stochastic determinism** proper to very **complex systems**. The same type of **attractors** appears in many other **situations** dependent from the **sequence** of **interactions** between various **initial conditions**. More generally, this is a **chaotic attractor**, for which, as stated by R. MAY "arbitrary close **initial conditions** can lead to **trajectories** which, after a sufficiently long **time**, **diverge** widely. This means that, even if we have a simple **model** in which all the **parameters** are determined exactly, long term **prediction** is nevertheless impossible" (1976, p.466).

In a **metaphorical** – but not at all rigorous – way, the so-called “butterfly effect” in weather forecasts says that, if a butterfly flaps its wings somewhere in the States today, it may produce a typhoon in the Eastern Pacific one month later, i.e. a small local initial **effect** may trigger a **snowball effect** eventually leading to a gigantic accumulative **event**, possibly faraway in **space and time**.

0347

BY-PRODUCT¹⁾

A secondary product or **side-effect** of the **activity of a system**.

By-products or **side-effects** are mainly results of the **activities** of artificial **systems**. Save (very significant) exceptions, they are generally damped by the **environment**. However various problems may become serious.

First, while slight **side-effects** or limited quantities of by-products can be absorbed by the **environment**, massive quantities may suffocate it.

Secondly, there is a specific **critical time** lapse for **assimilation** of by-products by the **environment**. A quite obvious case is half-life at a scale of millenia for radioactive **waste** produced by nuclear **energy** utilities.

Thirdly, some synthetic by-products (or even products) are unassimilable by the **environment**, which offers no known **process** to recycle them.

The by-products and **side-effects problems** are typically systemic, because they affect or may affect the whole natural setting, or a large part of it, during very long **periods**.

0348

BYSTANDER EFFECT¹⁾

The effect on other **elements** of some **input** into one **element** in a system.

This effect has been observed in human biological systems where “**cells** that suffer a direct hit from radiation alter the level of gene activity in neighbouring cells” (Jack LITTLE, quoted by R. EDWARDS, p. 22, 1998).

This implies some **communication** between these cells, probably “through chemical messengers” (Ibid.)

Conversely, where there is a **communication link**, a bystander effect is probably possible. A search for **bystander effects** in societies should eventually be rewarding.

0349

BYTE⁵⁾

A set of various **bits**.

The most common is the octet, which permits the identification of one possibility among 256 ($2^8 = 256$). A kilobyte equals to 1024 bytes and a megabyte is one million bytes.

C

0350

CALCULUS FOR SELF-REFERENCE²⁾

This logical calculus has been introduced by F. VARELA as an extension of G. SPENCER BROWN's **calculus of indications** aiming “... to encompass all occurrences of self-referential **situations**” (VARELA, 1975, p.5).

VARELA explains: “This is done through the introduction of a third state in the form of **indication**, a state seen to arise **autonomously** by self-**indication**” (Ibid.).

This third state represents the unavoidable **organizational closure** of the **observer**. In VARELA's words: “... a third, not so obvious but distinct **domain**, of a self-referential **autonomous** state which other laws govern and which *cannot* be reduced by the laws of the dual **domains**. If we do not incorporate this third **domain** explicitly in our field of view, we force ourselves to find ways to avoid it as has been traditional) and to confront it, when it appears, in **paradoxical** forms” (Ibid., p.19).

Known, assumed and well understood self-reference leads to a quite different viewpoint in comparison to unconsciousness of self-reference (see “**Self-reference in logic**”).

For a complete development of this calculus, see VARELA'S reference.

→ **Laws of form**

0351

CALCULUS OF INDICATIONS²⁾

A fundamental arithmetic that forms the ultimate basis of **Boolean** algebra. It has been introduced by G. SPENCER BROWN in his book “**Laws of Form**” (1969, 1979).

F. VARELA states: “By succeeding in going deeper than **truth**, to indication and the laws of its form, he has provided an account of the common ground in which both logic and the **structure** of any **universe** are cradled, thus providing a foundation for a genuine **theory of general systems**” (1975, p.6).

BROWN's calculus of indications starts from the ideas of **indication** and **distinction** as “...a necessary condition for an act of **indication** is the drawing of a **distinction**. The **form** (**paradigm**) of **distinction** is taken as *the form* (**paradigm**). All other **forms** (**paradigms**) are taken out of (follow from) *the form*” (R.A. ORCHARD – 1975, p.102).

“A **state** distinguished by the **distinction** is marked with the mark 1 and the **state** is called the marked **state**” (Ibid.).

Arrangements (i.e. combinations) of marked and non-marked **states** and the use of a directional barb allow for the development of the whole of calculus of indications.

0352

CANTOR SET (Triadic)²⁾

This set, imagined by Georg CANTOR towards the end of 19th century is probably the first ever abstract **representation** of a **fractal** set.

It is constructed, starting from a segment, which is divided in three equal parts, the middle third being removed. This operation is renewed on the two subsisting segments ad infinitum (supposedly!). In this way, we should obtain finally an infinity of points... whose total length dimension, or linear measure, would be zero. The Cantor triadic set has a fractal dimension of 0.63. Another Cantor set can be constructed removing at each stage two fifth segments within the remaining part of the original segment. It has also a zero linear measure and its **fractal dimension** is 0.68.

The Cantor set is **self similar**.

If we could invert the construction **process** of the Cantor set (i.e. from an infinity of points to a complete segment) we would have modelled the genesis of a macrolevel **system** constructed from discrete **parts**.

Other mathematical objects of the same type are the “snowflake” Koch curve, and the Peano curve, made from an infinitely folded segment which finally would wholly cover a surface. There are also objects of the same kind in three or more dimensions.

0353

CAPSULATION^{1) – 2)}

The enclosure of a number of hitherto independent **elements** within a common **boundary**.

Such an **event** is generally a result of some kind of pressure within the common **medium**. The more or less accidental concentration of numerous **elements** in a reduced **space** produces **crowding** and, due to the increasing closeness of the **elements**, these start to interact, whether being of the same or of different types. The boundary defines an incipient internal **space**, in opposition to, but in **communication** with the external one, i.e. defines an **invironment** and an **environment**.

A near synonym also used is “**encapsulation**”

0354

CARRYING CAPACITY¹⁾

1. “... The **population level** for long-range survival” (H. ODUM, 1983, p.125).

2. “The maximum number of living things that can be supported indefinitely by a given **eco-system** or area without deterioration” (UNESCO-UNEP Glossary, 1983, p.7).

These definitions are proper to **ecology** and related to basic physical **resources** (mineral **cycles**, soil, water **levels**, plants, etc.) However there are also **limits** to the carrying capacity of **transmission channels** of any kind.

An eventual larger carrying capacity must be "based on the continued **flow** of the concentrated potential **energy**" (ibid., p. 123).

The carrying capacity of any **biotope** or **ecosystem** remains stable only when the **environmental** conditions remain within stable **limits**. This does not exclude some more or less periodic maxima or minima, for example during winter, or dry season. Very long term **constraints** are more elusive and, as a result, long range carrying capacity is quite difficult to evaluate with reasonable certainty.

Still another definition is the following: In any **subsystem** – but particularly in a **niche** in an **ecosystem**, the ultimate **limit** to the number of **elements** or individuals able to survive in the **niche**.

The ultimate limit is generally characterized by heavy **overcrowding**, which leads to blockage (for instance in vehicles traffic on trunclal roads), massive destruction (by **epidemics**, for example), massive emigration (as the one caused by overpopulation and the potato blight famine in the 1840's in Ireland) or gregarious **mutation** and **behavioral change** (as in **Dicystelium discoideum** or in solitary locusts reaching a **critical density**)

0355

CASSANDRA'S SYNDROME ¹⁾⁴⁾

The fate of any clear-sighted individual, able to **forecast** some future **event**, but nearly never believed. This was the case of Cassandra, daughter of King Priam of Troy, who was endowed with such a gift, but fated by the god Hermes never to be given heed. (Homer's Iliad)

The syndrome is in fact systemic and specific to social systems. Some very few individuals are endowed with foresight because they perceive quite concealed and unobtrusive **interactions** in a **situation** or **issue**, that could later on trigger very considerable and possibly dramatic consequences. Meanwhile, common people remain shortsighted and, as they see nothing special in the situation, they don't believe "Cassandra".

Another curious greek tale, more or less similar, is about Tiresias, the Theban prophet, who was blind. In many cases, the foresighting individual seems to be blind to the present issue, as his forecasts or prophecies appear to be incredible according to what common people perceive from the actual facts. Tiresias also is thus not understood or believed.

Let us hope a better fate for systemists concerned or worried about the future of human systems!

→ **Interception; Prospective**

0356

CATABOLISM ¹⁾

The **process** of dis-**assimilation** and emission or elimination of products by a **living system**.

The catabolic **process** includes the following phases:

- **Production**: the synthesis within the system of specific material or energetic products destined to be exported as **outputs** into the **environment**.

- **Encoding**: the **recoding** of internal **information** into a public **code** in order to produce **information** that can be interpreted and used by other systems (specially in **human systems**).

- **Output transduction**: The translation of the prepared products from the system through its **boundary** into its **environment**.

Not all products – specially those of **human systems** – are innocuous for the **environment**. Some, as for example long life radioactive **wastes**, cannot even be artificially **recycled** in an efficient manner.

For the respective **roles** of the **subsystems** concerned in catabolic **processes**, see J. MILLER's **20 critical subsystems**.

The process of absorption and **assimilation** of **inputs** by a system is called "**anabolism**", while "**metabolism**" is the generic term for the whole **process** of absorption, **transformation** and emission of **matter**, **energy** and **information**.

In a more or less **analogic meaning**, higher **level living systems** (groups, enterprises, **organizations**, **communities**, etc...) all catabolize specific **outputs**.

0357

CATALYSIS ^{1) – 5)}

The recurrent action of an **element** in a system, which activates some **process**.

This is a systemic extension of the classical chemical **model** of catalysis.

M. ZELNY observes that "...it is unreasonable to assume that the catalyst is unaffected by its participation in the production of **links**. Each single act of production diminishes its catalytic power. Initially, when there is a lot of free substrate, the number of produced **links** is naturally very high. At the same time, the number of holes necessary for **disintegration** is still very low" (1977).

However, the catalyst uses up the **substrate** and, as a consequence, finds less opportunities to act. It is its own **activity** which limits, and finally suppresses its capacity for **activity**.

This seems to open avenues for the explanation of what ZELNY calls "built-in death" of **autopoietic organizations**.

0358

CATALYSIS (Auto-) ²⁾

"**Cycle** where a product of the reaction catalyzes its own synthesis" (LASZLO 1992, p.242).

This is the simplest type of catalysis.

It may lead to a **runaway process** in the case of an unchecked multiplicative reaction. However, auto-catalytic processes are generally inserted in more complex **hypercycles**, organizationally closed.

As stated by G. PASK, the concept "is used in **cybernetics** in connexion with all kinds of **change** in the **state** of the system" (PASK, 1961, p.114).

Other authors use the term "**Self-Catalysis**" in an apparently similar sense (see hereafter).

0359

CATALYSIS (Cross-) ²⁾

"**Cycle** where two different products (or groups of products) catalyze each other synthesis" (E. LASZLO, 1992, p.242).

LASZLO observes that cross-catalysis leads to catalytic **cycles** or **hypercycles** and "tend to be naturally selected in the course of time by virtue of their remarkable **stability** under a wide range of conditions." (ibid)

He adds: "The formation of cross-catalytic **hypercycles** allows dynamical systems to emerge on successively higher **levels of organization**" (ibid., p.244).

0360

CATALYSIS (Self) ²⁾

Reproductive **process** of complex **elements**, by the ordering action of some of their **parts** on simpler **elements** already present in their **environment**.

According to J.de ROSNAY: "A peculiar form of **fluctuations** which plays a fundamental role in the genesis of an organized **structure** is the self-catalytic reaction. There is self-catalysis when products of a reaction act as a catalyzer in this same reaction. A self-catalytic reaction may lead to the **emergence** of a **structure** ordered out of an **homogeneous medium**. It is the case of a **chain reaction** which produces (by **random** molecular collisions) a more complex molecule capable to **catalyze some stages of its own formation**. The chain closes on itself and produces a **positive feedback** starting from simpler molecules already present in the **medium** and available as building blocks. The complex molecule builds itself and the **process** accelerates with the help of the just created products" (1975, p.227).

This **process** is active in the DNA and RNA chain of reproduction... and thus in the reproduction of superior **organisms**.

It plays also a role in the autopoietic **process**. Self-catalysis is an important mechanism for the **emergence**, multiplication and **stabilization** of **complex systems**.

0361

CATASTROPHE ^{2) – 3)}

The sudden **transition** of a **trajectory** from one **basin of attraction** to another.

In terms of H. and L. SABELLI: "Catastrophes are the simplest forms of **bifurcations**, i.e. the **transition** from one **point attractor** to another (i.e. **choice** or rejection). The simplest catastrophes are governed by only two **control** variables: a) **asymmetric**, which at mid values is associated with large **changes** between the opposite **modes**, while at extreme values is associated with small **changes** around the **modes**; and b) **bifurcating**, which at low values is associated with **continuous** outcomes and at high values, with a **discontinuous** outcome" (1992, p.663).

0362

CATASTROPHE (Delayed)²⁾

A catastrophe occurring after a long and slow **accumulation** of small **effects**.

These catastrophes have been discussed by M. KARSKY (1993, p.1413-21). This is a very dangerous type of **phenomena**, in natural as well in artificial systems. Small **individual effects** are generally irrelevant, and perceived as such. But, as shown by KARSKY, the damped **oscillations** they provoke can suddenly "jump out of the track" and lead to new and unexpected **macroscopic** qualitative **effects**. KARSKY observes that: "this **phenomenon** takes place only in a very narrow band of **parameters** variations and may easily pass unnoticed in absence of a systematic policy of **simulation** through multiple **scenarios**. It could however explain in some cases the occurrence of seemingly inexplicable catastrophes" (p.1417).

That the **accumulation** be slow implies another danger: the **nonperception** of the progressive buildup of a **macroscopic change** in the making. When finally it becomes evident that a dramatic **change** is to occur, it is generally too late to do something about it.

→ **Cycles and Effects (Delayed)**

0363

CATASTROPHE THEORY^{2) - 3)}

"A **topological** theory describing the **change** of a system's **structure** along a **continuous morphogenetic** landscape, including occasional jumps" (K. KRIPPENDORFF, 1986, p.9).

In R. THOM's, founder of the theory, words: "It gives a kind of local description of a system within a **control parameters space**. One may modify the **controls** on the basis of a certain system of **values** and describe, through the choice of convenient surfaces in this **space**, the **continuous variations** and the occurring **catastrophes**" (1993, p.30).

THOM thus defines the elementary catastrophe: "Any **conflict situation** between local **regimes**, potential minima, which may occur in a stable manner on the four dimensional **space-time**" (1974, p.71).

K.B.DE GREENE states: "Catastrophe-theoretic **models** deal with systems that show **multiequilibrium behavior** and usually show a path **irreversibility (hysteresis)**" (1990, p.55).

Catastrophe theory is a formalized geometrical theory that cannot even be sketched within the limits of this work (see R. THOM's, E.C. ZEEMAN's and T. POSTON and I. STEWART's references) Let us only try to describe its nature and the wide scope of its applications, as well as to warn against its improper **metaphorical** uses.

T.F.H. ALLEN and Thomas B. STARR explain it as: "A theoretical construct used for the description of certain types of disjunct **behavior**. It derives from a **topological** consideration of folded surfaces describing the **interactions** between **variables**. Catastrophe theory is rather specific in its appropriate application, although it serves a more general usefulness as a mathematical **metaphor**" (1982, p. 263).

F. HEYLIGHEN observes: "It was developed by R. THOM (1975) in order to model the (**continuous**) **development** of (**discontinuous**) forms in **organisms**, thus extending the much older work of the biologist D'ARCY THOMPSON (1917)" (F. HEYLIGHEN, 1997, p.33).

Catastrophe theory is undoubtedly a systemic one, since it addresses to a wide field of general **phenomena**, starting from a qualitative **topological** view and giving them a common basic ground through **isomorphic models**. It is basically a theory of **discontinuous phenomena**, related to sudden **phase transitions**, marking a jump from one **attractor** to another. It is closely related with the following topics: **Field gradients** leading to **singularities**; **markovian systems** and **LIAPOUNOV stability**; **bifurcations** and **unfolding**; **morphologies** and **morphogenesis**; and the different corresponding **attractors**.

The best known part of catastrophe theory are the seven basic elementary catastrophes, upon which according to THOM a general catastrophe theory is to be built upon. (in ZEEMAN, 1977, p.633)

The seven elementary catastrophes (a synthesis of THOM's (1974) and ZEEMAN's (1977) presentations):

	Dimensions		Typical Phenomena
	of state space	of control space	
a) Cuspoids			
Fold	1	1	No dynamics
Cusp	1	2	Hysteresis, breakdown, sudden regime change, phase transition
Swallowtail	1	3	Conflict between two regimes
Butterfly	1	4	Stability in a zone through equilibra- ted forces

	<u>Dimensions</u> <u>of state of control</u>		<u>Dimensions</u> <u>Typical</u>
	<u>space</u>	<u>space</u>	<u>Phenomena</u>
b) Umbilics			
Hyperbolic	2	3	breaking waves
Elliptic	2		3 submitted to an organization center
Parabolic	2	4	Surface penetration with break-through

Graphical **models** have been produced by THOM (1972).

Numerous applications of the elemental catastrophes have been proposed in physics and chemistry (the relation to **dissipative structuration** and **bifurcations in far from equilibrium systems** is still a fuzzy area); in engineering; in biology and embryology; in animal and human ethology; in psychology (**perception** and **behavioral** shifts) and in social sciences (economics, markets shifts).

However, J. CASTI observes that there have been "... attempts by practitioners to use the theory as a vehicle for **predictions in situations** where it can at best be used only to explain" (1994, p.48).

In effect, in some cases – undoubtedly and at least partly due to the "mediatic" name given by THOM to his theory – the catastrophe **models** became a somewhat misused and abused **metaphor**.

0364

CATCHMENT^{1) - 2)}

The incorporation by a system of some formerly independent **elements** or systems.

Catchment is in fact a **process** of expansion of the **attractor basin** of the system, corresponding to the expansion of its **field** of influence.

A typical example is the catchment by a river **basin** of some adjacent area.

0365

CATEGORIES FORMATION³⁾

According to D. BOHM and F.D. PEAT: "... categorizing involves two actions: **selection** and collection. According to the common latin root of these two words, *select* means "to gather apart" and *collect* means "to gather together"...

"The second phase of categorization is that some of the things that have been selected (by virtue of their difference from the **background**) are collected together by regarding their differences as unimportant while, of course, still regarding their *common* difference from the **background** as important" (1987, p.112).

All dogs are selected in the animal taxonomy, possibly together with cats and horses, as distinct from, let us say, marine mammals. Thereafter, we collect them in the family canidae, and more specifically in the species *canis*, in order to distinguish them from any other mammals.

Systemic categorization, while essentially the same, may be used in an inverse way: we abstract very general categories, that can be used to launch **transdisciplinary** bridges. The **hypercycle**, for instance, as a generalized systemic **model of catalysis**, may be observed as a **process** in numerous systems of very different classes: cyclical chemical reactions, enzymatic reactions in **living systems**, complex **autopoiesis** in **social systems**.

→ "Structural differential".

0366

CATEGORIES (Relativity of)³⁾

According to BERTALANFFY: "The categories of experience or forms of intuition, to use KANT's term, are not a universal a priori, but rather they depend on the psycho-physical **organization** and physiological conditions of the experiencing animal, man included. This relativism from the biological standpoint is an interesting parallel to the relativism of categories as viewed from the standpoint of culture and **language**" (1962, p.75).

We are indeed enclosed in a "observational bubble" from both viewpoints and we should thus carefully practice **ontological scepticism** and **hypothetical realism**.

In G.M. WEINBERG's words: "The most dangerous pitfall in developing category systems is imagining that one system of **paradigms** is more "real" than another" (1975, p.34).

0367

CATEGORIZATION¹⁾³⁾

"The ability to group **objects** and **concepts** by their relative **similarities** or differences" (M. CAUDILL, 1994, p.18)

Isomorphisms and **homomorphisms**, as well as **metaphors**, are depending on initial categorization.

0368

CATEGORY³⁾

A defined **class** in a system of **classification** of **objects**, **processes** or **relations**.

J.A. GOGUEN and F. J. VARELA write: "The intuitive idea of a category is that it embodies some **structure** by exhibiting the **class** of all **objects** having that **structure**, together with all the **structure** preserving **mappings** or **morphisms** among them" (1979).

R. ROSEN introduced a systemic concept of "category", also different from the one traditional in philosophy, and more formal:

"... a category consists of the following data:
1. A collection of **objects**, which we shall design by A, A',...

2. A function assigning to each pair (A,A') of **objects** in the category, a **set** denoted by H(A,A'), the **elements** of which are called **mappings** or **transformations**. This **set** may be empty for some pairs (A,A').

If $f \in H(A,A')$, then we shall call the **object** A the **domain** of f; the **object** A' will be called the **range** of f." (1960, p.46)

ROSEN also introduced the concept of sub-category, within a previously defined category and stated "... the **objects** and **mappings** of a sub-category themselves comprise a category" (p.47).

The preceding notions give the bases for a formally organized **taxonomy** of systems and **subsystems**, and has been introduced by ROSEN for the "**Representation** of biological systems".

0369

CATWOE²⁾

"A mnemonic of the six crucial characteristics which should be included in a well-formulated **root definition**" (in **Soft System Dynamics Methodology**) (R. RODRIGUEZ ULLOA, 1999).

The six crucial characteristics are:

Actor: A person who carries out one or more of the **activities** of the system.

Customer: A beneficiary or victim of the system's **activity**.

Environmental constraints: The external impositions which the system takes as given.

Owner: The individual who find himself in the problem **situation** and could modify or destroy the system.

Transformation process: The core **transformation process** in a **human activity system**, which can be expressed as the conversion of some **input** into some **output**.

Weltanschauung: The (unquestioned) **image** or **model** of the world which makes this particular **human activity system** (with its particular **transformation process**) a meaningful one to consider.

The CATWOE characteristics were originally introduced by P. CHECKLAND

0370

CAUSAL EXPLANATION³⁾

HUME, as quoted by F. DAVID PEAT (1987, p.40), wrote: "We have no other notion of cause and **effect**, but that of certain **objects** which have been *always conjoined* together... We cannot penetrate into the reason of the conjunction". Elaborating on HUME, PEAT concludes: "The chain of linear **causality**, therefore, is a mixture of **habit**, belief, and common sense. But this common sense is based on a number of assumptions, namely:

- That two **events** are unambiguously separated from each other and have their own independent existence, as, for example, two bodies with well defined **boundaries**.
- That some contact, force, or influence flows from one body or **event** to the other.

- That there is a clear **flow of time** with the cause occurring in the past and the effect in the present" (p.41).

The spanish philosopher J. MARIAS writes: "... causal explanation has to be schematic and universal, leaving out the concrete individuality, which is the most real part of the thing explained" (1975, p.145).

As stated by R. LILIENFELD: "... logical or pseudo-logical schemes ... gain manipulability at the cost of reality" (1979, p.5).

In PEAT's terms, the supposed **chain of causality** is "in fact a complex **network of causality**". And "The more the **limits** of this **network** are extended, the more it is seen to stretch out over the entire earth and ultimately the universe itself" (p.45). We are thus faced with two **practical** problems when we want to **construct causal models**:

- Where to fix reasonably – i.e. on the base of a sufficiently **global information** – the **limits** of the **network** related to the system, **situation** or **phenomenon** we seek to modelize? ("To talk of planetary influence on a game of tennis is obviously far-fetched" (p.45) – But possibly not so the effects of planetary temperature increase on investment at a sea-side resort at a 30 years **time lapse**.
- How much should we extend the **network** into the past, admitting that we can obtain reliable **information** For example, using historical and geological **information** about the Mississippi flood plains.

E. JANTSCH equates causality with **local determinism**, "... often effective in describing microaspects of **change** in a nonsystemic and short range perspective. Newtonian mechanics belongs here as well as many predictive cause/effect **models** in the social domain" (1975, p.98).

(POINCARÉ's **three bodies problem** shows that Newtonian mechanics with all its achievements, is indeed a simplified view of celestial mechanics).

Complex systemic **models** are still **models**, but at least, they aim at a more complete **description** of real entities. To construct such **models** we are in need of **cybernetic** and systemic conceptual means, able to reflect a higher degree of **complexity**. New logical and mathematical formalisms are also required, as for example SPENCER BROWN's Laws of form; ZADEH's **fuzzy sets**, or LORENZ, SMALE's et al, **deterministic chaos**.

We thus end up with, in A. ARIELY's words: "... an album of **maps** to be studied not as an ultimate truth, but as way-points that the applicator can use provided that he verifies the **model** by his intuition, imagination and the conditions of the problem at hand" (1979, p.12).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0371

CAUSAL LOOP ¹⁾ - ²⁾ - ³⁾

A **cause** and **effect** relation closed on itself.

A causal loop is the result of a **feedback** of the **effect** upon the **cause**. **Interconnected** causal loops may become very complex. This **model** has been extensively explored by M. MARUYAMA (1994, p.75-87).

The **feedback** can also take the form of a **circular** and **cyclical** chain of **feedbacks**. It can reduce, maintain or amplify the **process**.

MARUYAMA explains: "The **dynamics** of causal loops has two aspects: quantitative and qualitative. The former is a matter of **change amplification** and **change** counteraction; the latter deals with **heterogeneity** and interrelations among **heterogeneous elements**, as well as the creation of new **patterns** and inventive **processes**" (p.75).

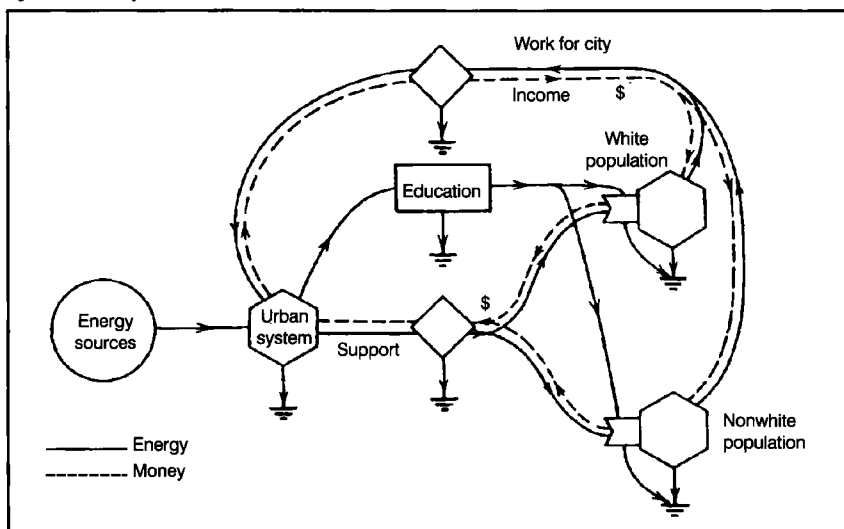
At the beginnings of **cybernetics**, much emphasis was on reducing or stabilizing causal loops. This is still the case in some disciplines. In MARUYAMA's words: "Causal loops have become invisible in the **black box**, and we have fallen back on loopless **input/output relations**". LEONTIEFF's **input/output matrixes** in economic theory are a typical case.

MARUYAMA moreover observes that: "Economists tend to ignore **change-amplifying** causal loops and believe in **equilibrium** or the **cycle** almost superstitiously" (p.75). See "**Economics in systemic terms**".

MARUYAMA offers a causal loops notation with the needed explanations (p.76-80). He insists on the importance of **initial states**, **reversal effects** and of **time delays**.

see figure below

Figure: see entry **CAUSAL LOOP**



Causal loops: an example

From H. T. ODUM: 1971, p. 36

0372

CAUSAL PROCESS (Mutual) ¹⁾ - ²⁾

This model was introduced by M. MARUYAMA in 1963. He observed that the classical **model** of **cybernetics** was "focusing on the **deviation-counteracting** aspect of the mutual **causal relationship**, (but that) cyberneticians paid less attention to the systems in which the mutual **causal effects** are **deviation-amplifying**". He noted that the latter: "... are ubiquitous: **accumulation** of capitals in industry, **evolution** of **living organisms**, the rise of cultures of various types, interpersonal **processes** which produce mental illness, international **conflicts**, and the **processes** that are loosely termed as "vicious circles" and "composed interests"; in short, all **processes** of mutual **causal relationships** that amplify an insignificant or accidental initial kick, build up **deviation** and **diverge** from the **initial condition**" (p.233).

He called the study of these **processes** "the second **cybernetics**" (not to be confused with von FOERSTER's **cybernetics of 2d order**). He observed that: "The **deviation-counteracting** mutual **causal process** is also called "**morphostasis**", while the **deviation-amplifying** one is called "**morphogenesis**" (Ibid).

The similarities with various **processes** and **models** discovered later on is evident: **dissipative structuration**, **bifurcations**, **sensibility to initial conditions**, and **chaos**.

He stated, for example: "... when the **deviation amplification** mutual **causal process** is combined with **indeterminism**, here again a revision of a basic law becomes necessary. The revision states: A small initial **deviation**, which is within the **range** of high probability, may develop into a **deviation** of very low probability (or more precisely, into a **deviation** which is very improbable within the **framework** of prob-

abilistic unidirectional **causality**). Not only the law of **causality**, but also the **second law of thermodynamics** is affected by the **deviation-amplifying** mutual **causal process**" (p.234).

MARUYAMA proposed the following simple **model** of the **deviation amplifying** mutual **causal process** (practically a **cellular automata**, complete with graphic **representation**):

"Let us imagine, for the sake of simplicity, a two-dimensional **organism**. Let us further imagine that its cells are squares of an equal size. Let us say that the **organism** consists of four types of **cells**: green, red, yellow and blue. Each type of **cell** reproduces **cells** of the same type to build a tissue. A tissue has at least two **cells**. The tissue grows in a two-dimensional **array** of squares. Let us give a **set of rules** for the **growth** of tissues:

"1. No **cells** die. Once reproduced, a **cell** is always there.

"2. Both ends of a tissue grow whenever possible, by reproducing one **cell** per unit time in a vacant contiguous square. If there is no vacant contiguous square at either end, that end stops growing. If there are more than one vacant contiguous squares at either end, the direction of the **growth** is governed by the preferential **order** given by rules 3,4, and 5.

"3. If, along the straight line defined by the end **cell** and the penultimate **cell** (next to the end **cell**) there are less than or equal to three **cells** of the same type (but may be of different tissues) consecutively, the preferred direction is along the same straight line. If that direction is blocked, follow rule 5.

"4. If, along the straight line defined by the end **cell** and the penultimate **cell**, there are more than or equal to four **cells** of the same type (but may be of different tissues) consecutively, the preferred direction of **growth** is a left turn. If a left turn is impossible, make a right turn.

"5. If, when a straight **growth** is preferred, the straight **growth** is impossible because the next square is already occupied, do the following. If the square to which the straight **growth** would take place is filled with a **cell** of the same type as the growing type, make a left turn. If the square ahead is filled with a **cell** whose type is different from that of the growing tissues, make a right turn.

"6. The **growth** of the four types of tissues is timewise out of **phase** to each other: green first, red second, yellow third, and blue last within a **cycle** of one unit of **time**" (p.237).

MARUYAMA's **rules** are practically **framing algorithms**.

A very important feature of the **model** is the **initial state**, i.e. the disposition of the first four units on the grid (MARUYAMA's "initial kick"). And, of course, the player is furnishing the **energy** for the **process** of construction.

(This kind of graphical experience is much less complicated in practice than would appear by reading the rules).

MARUYAMA's graphics are self-structuring, i.e. *self-constraining*, in accordance with the chosen rules, which may be widely varied. This is very significant for **concrete systems**, which are always based on ruled **interrelations** between some more or less reduced types of **elements**. CONWAY's **games of life** are of the same kind, even if based on quite different rules.

→ **Positional value**

0373

CAUSALITY³⁾

The **link in time** between two **events** such as the first one is necessarily followed by the second one, through some well defined **process**.

This is the classical, strictly **deterministic** concept of causality. The first **event** is generally supposed to be *the only* cause of the second one, or at least its principal and overwhelming cause. Moreover, this **relation** must be verified each **time** the second **event** occurs after the first one. This implies some well defined and invariable sequence in a characteristic **process**.

This classical oversimplification of the Aristotelic concept of causality, useful as a first approximation and for prediction, has been now widely reconsidered and refined in **systemics** and **cybernetics** (see hereafter).

For a recent wide-embracing reconsideration of the multiple hues and shades of the concepts of **cause** and causality, see Chr. HARDY (2001, p. 44-55)

0374

CAUSALITY (ARISTOTELIAN)¹⁾³⁾

Just as a useful general reference, the four basic causes Aristotle used to answer all "why?"-questions are remembered hereafter:

- material cause
- efficient cause
- formal or formative cause
- final cause

→ **Causality; Determinism; Random processes; Randomness; Time**

0375

CAUSALITY (Circular)

→ **Causality (Cyclic)**

0376

CAUSALITY (Cyclic)^{2) - 3)}

"A cyclic causal **relationship** (is)... a **sequence** of coupled cause-effect **relationships** that leads back to its starting point: A - B - C - ...A" (HEYLIGHEN, 1989, p.374).

However "It is only possible to move toward the future, not toward the past" (p.375). Thus, cyclic causality does not imply **reversibility**. Or, as stated by HEYLIGHEN: "If a distinguishable **change** has occurred, then at the global **level** (i.e. the **level** where all observed **distinctions** are taken into account), there was no real causal cycle and it is possible to define an absolute ordering between all the **events** in the causal chain" (p.377).

To avoid this type of **ambiguity**, it should probably be advisable to avoid the voice "Cyclic causality", or even "Circular causation" (as observed by R.N. ADAMS - 1988, p.68) and to speak, for example of "causality by recurrent **feedback**".

0377

CAUSALITY (Limits to)³⁾

F. HEYLIGHEN states: "Causality appears to be a local concept, which can be used to describe certain aspects of certain **processes**, but which cannot be simply generalized in order to build an encompassing, **deterministic** and reversible theory, such as classical mechanics. In other words, general **processes** are only partially causal. They only conserve certain **distinctions**, perhaps only during a limited **time interval**" (1989, p.372).

We should first remember that past and present **events** have been univocally determined: they occurred in one and only one manner, as a result of a concatenation of some or many concurrent **causes**.

Before their occurrence, they were only partly and conditionally predictable, which is the case of all future **processes**.

0378

CAUSALITY (Linear)^{2) - 3)}

A causal relation without **feedbacks**, in which cause comes always "before" and **effect** "afterwards".

This is the classical concept of causality, of strictly **deterministic** character, allowing perfect **predictability**. It implies the absolute, or for practical purposes, near absolute **stability** of the general **environment** of the **process** inside and outside of the system ("Et ceteris paribus").

While, in E. JANTSCH's words: "It is frequently efficient for the description of **changes** in a non-systemic and short term perspective" (1975, p.118), it is also frequently more or less useless for complex and/or **long term forecasting**.

0379

CAUSALITY (Multiple)¹⁾

The existence of various **simultaneous** and concurrent causal lines in a **complex system**.

Multiple causality is closely related with the very nature of **complexity**. In a **complex system**, a number of different **processes** must take place at any instant, and the **effects** constantly interfere with each other in varying ways. This generates a kind of global **determinism**, but with some, or much, leeway for specific **processes**. The only basic **constraint** is that none of these should infringe the general conditions necessary for the **survival** of the system.

Important consequences are that very numerous combinations of **interactions** are normally possible among the various **processes**, and that their **simultaneous** character, combined with different **time lags**, lead to some **instability**, or possibly to an **ergodic**, or even **chaotic behavior**.

→ **Ergodicity and Homeostat**

0380

CAUSALITY (Mutual)^{1) - 2)}

The **interactions** between two or more **processes** in such a way as that anyone evolves in a way conditioned by some or all of the others.

The **concept** has been introduced by M. MARUYAMA (1968). Mutual causality **processes** evolve from some initial **situation** through the **operation** of specified **rules** within a limited or unlimited **space**. They are generally **pattern-forming** and are closely related to **cellular automata** and **self-organizing networks**. See: "Causal process (Mutual)".

Some mutual causality **processes** can be self-limitating, while other can become **cyclical** or lead to a **runaway event**.

When mutual causal **relationship** appear between more than two **elements**, a multi-loop mutually causal system may develop.

0381

CAUSALITY (Principle of absolute)³⁾

1) All **distinctions** are **invariant**.

2) "All causes of an **event** are predictable if the **states** of the system and the **behavior laws** are known" (K. KORNWACHS & W.von LUCADOU - 1989, p.135).

The principle may be considered as the basic axiom of classical **determinism**. However, according to KORNWACHS and von LUCADOU: "The principle of **determinism** implies that every **event** has its special causes. There is no **event** within the system without any cause" (Ibid).

F. HEYLIGHEN explores some of the foundations of the causality principle in the following way:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"Objects are supposed to have an **invariant identity**. During their movement they do not disappear or merge with other **objects**, and no **objects** are created out of the void or by the breaking up of existing **objects**. In other words, the **distinction** between **object** and **background** is always conserved

"The attribution of a predicate to an **object** is objective, and all **observers** are supposed to agree on it. Hence, the **distinction** between having a property or not having it is also **invariant**.

"The same apply to propositions that are either true or false, independently of the **observer**, and to the **time** ordering of two **events**, which are either simultaneous, or the one precedes the other one. Hence, propositional and temporal **distinctions** are also **invariant**.

"Again the same principle applies to **dynamical constraints**: A **transition** is either allowed or not allowed, without any **ambiguity**.

"Finally the principle applies to state **trajectories**: Two **trajectories** starting at distinct **states** at a certain instant will always remain distinct and have always been distinct".

In conclusion, all **distinctions** between **objects**, between predicates, between different **trajectories**, between **truth** and falsity, between past and future, between possible and impossible, are **invariant**; they remain the same for all times and for all **observers**. This absolute **distinction** conservation can be taken to be the defining characteristic of the classical way of **representation**.

"...each of the nonclassical **representation** can be characterized by the nonconservation of a particular type of **distinctions**" (1990 a, p.434-5).

These basically **ontological** assumptions are very old in the occidental philosophical and intellectual tradition, being already present in Plato (The myth of the Cavern). It has been historically very useful, because it permitted the establishment of the basic sciences of **macroscopic** simple **processes**. But it has been a hindrance to the understanding of **complexity** and the consensual nature of **knowledge**.

HEYLIGHEN concludes: "...the classical **representations** are the result of a completely closed **observation cycle**. The **state** of the system can be perfectly prepared by the **observer**, the **evolution** of prepared **states** in the system is completely causal, the new **states** of the system can be perfectly detected, and the **observer** is supposed to possess all **information** and **knowledge** needed to predict or explain the detected **states** of the system (this is the assumption of perfect, "unbounded" rationality)" (p.435).

This **causalism** is practically a metaphysical stance and has been the dominant **paradigm** of classical science since NEWTON. It implies an overly simplifying **ontological determinism**, which is now in process of deep reconsideration. (see f. ex. M. BUNGE's work - 1979).

0382

CAUSATION (Downward) ¹⁾ - 2)

D.T. CAMPBELL introduced this **concept** in the following way: "Where natural **selection** operates through life and death at a higher **level of organization**, the laws of the higher-level selective system determine in part the **distribution** of the lower-level **events** and substances. **Description** of an intermediate-level **phenomenon** is not completed by describing its possibility and implementation in lower-level terms. Its presence, prevalence or **distribution** (all needed for a complete explanation of biological **phenomena**) will often require reference to laws at a higher **level of organization** as well... All **processes** at the lower **level** of a **hierarchy** are restrained by and act in conformity to the laws of the higher **levels**" (1976, p.87).

Since the higher **levels** were as well somehow constructed from **bottom up**, the following comment from R.N. ADAMS seems important: "That characterization... somewhat obscures the **self-organizing** quality of the **process**. The issue is more one of **control** than of causation; and it is not simply "downward" since it also involves the **feedback** from the subassemblages to the center" (1988, p.153).

0383

CAUSES AND CONSEQUENCES DIAGRAM ²⁾

A **sequential** graphical **model** that aims at the complete **description** of the antecedents and consequences of some **event**.

This a very practical systemic tool for **risk analysis** and **assessment**, based on preliminary studies of specific cases in some activity, generally industrial. Its use aims at the better **understanding** of what should be or not be done at each moment during the successive **stages** of some critical **situation**.

A. LEROY and J.P. SIGNORET, who describe the **methodology**, based on **binary sequences** of successive alternatives, give an interesting example of its use as applied to some risky incidents in oil extraction at sea. (1992, p. 34-5).

The **methodology** is quite similar to **expert systems**.

0384

CAUTION PRINCIPLE ¹⁴⁾

Innovation of any kind should be carefully scrutinized in order to try to understand their possible **side effects** and, in cases, to avoid them.

Unobtrusive possible effects may include **delayed effects**, **mass effects**, **spillover effects**, etc., all of them easily ignored or underestimated, but frequently quite difficult or impossible to overcome, once manifested. This is specially important in applications of scientific discoveries.

Countless examples have been registered during the 20th Century, as for example acquired resistance of many kinds of bugs to insecticides, and of pathogens to antibiotics, or unmanageable cars traffic in cities and roads.

The first condition for practical caution is the **understanding** of possible **links**, between apparently unconnected aspects, or eventual **accumulation** of effects **short, medium and/or long term**

At least a clearer **understanding** of not obvious effects permits a better balanced **evaluation** of **decisions** to be made, or not.

Caution principle is also known as "precaution principle"

→ **Cassandra's syndrome**; **Risks analysis**; **Risks in human issues**

0385

CELL ²⁾ - 5)

The most basic biological **level of organization** in J.G. MILLER's **taxonomy of living systems**.

Interconnected and interacting cells (1st **level of organization**) form **organs** (2nd **level**).

Cell also means an **element** in so-called "**cellular automata**".

J. HOFFMEYER (1995, p. 23) gives the **cybersemiotics** and **autopoietic interpretation** of the cell: "The simplest entity to possess real genuine **semiotic competence** is the cell. This is because the cell is a **self-referential system** based on redescription in the **digital code** of DNA"

0386

CELL 2 ¹²⁾

Any closed portion of **space**.

An entity with an **enveloppe** which defines an internal **space** and an external one is basically a cell, of whatever kind. Most generally, the **internal space** tends to acquire an **organization** different from the **outer one**.

0387

CELLULAR ARRAY ²⁾

"A subdivision of a limited **space** into units which completely fill the **space**" (1976, p.53).

K. CULIK II & A. LINDENMAYER state: "Tessellations and maps are examples of two-dimensional cellular arrays" (Ibid.). This is somewhat unexpected, since what the authors seem really to have in mind, are **dynamic** cellular arrays. (see following heading).

These authors, being mainly interested in biochemical and cytological aspects, concern themselves "... primarily with **neighborhood** aspects of such arrays, i.e. **topological** aspects, and not with their detailed metric **descriptions**". They thus choosed **graph representation**.

What they proposed is "... a powerful and general **mechanism** for defining **connection rules**, dependent on **node** and **edge labels**, **edge directions**, and on the **structure** of the **neighborhoods**" (p.54).

0388

CELLULAR AUTOMATA ARRAY ²⁾

"... an interconnected collection of similar sub-units ... (each of which is) usually not to be more complex than a finite **automaton**" (p.45).

A. LINDENMAYER and K. CULIK II define this **model** and state some shortcomings of former **models** of the kind: "In the case of the McCULLOCH-PITTS nerve **net models**, the problem is that the **size** of the array remains constant; furthermore, that the entire array behaves as a single finite **automaton**. In the case of von NEUMANN's **self-reproducing automata**, the array is laid out on a square grid and is allowed to grow only at the margins (i.e. the active part of the array). While these **structures** are as powerful as **TURING machines**, they are not suited to simulate in a realistic manner growing cells or multicellular **organisms**" (Ibid).

To remedy these limitations, the authors proposed a **modeling** method whose principle is what they call **parallel rewriting of graphs**.

The formalism they propose seems closely related to the specific problem of **internal growth of networks**, as for example in embryology and more generally in **morphogenetic fields**. The subject is also closely related to the "Physics of vegetal spirals" and **FIBONACCI series** (see St. DOUADY and Y. COUDER - 1993).

0389

CENTRALIZATION ²⁾

"The **process** whereby the **interaction** coefficients increase in a **part** of a system or in an individual **element**" (I.V. BLAUBERG, V.N. SADOVSKY & E.O. YUDIN, 1977, p.55) (Adapted).

BLAUBERG, SADOVSKY and YUDIN conclude: "As a result, small variations of this **part** (the leading **part** of the system) produce essential variations in the whole system" (Ibid).

Poly-centralization and hierarchized centralization appear possible.

0390

CENTRALIZATION (Progressive) ^{1) - 2)}

Emergence of a part of the system, which starts to act as a global center of **regulation** and **control** (According to A.D. HALL & R.E. FAGEN, 1956, p.22).

As the **complexity** of the system increases, the **coordination** between its numerous differentiated **functions** become more necessary and, at the same time, more difficult. This **coordination**, however, takes place automatically by the interplay of countervailing **regulations** at different hierarchical **levels**.

The global center of **coordination** appears at the higher **level** and must in principle take charge only of the most general **problems** which are significant for the system as a **whole**.

It can be said that centralization becomes excessive when the global center of **coordination** starts meddling inefficiently with local or specific **problems**, encroaching on the **regulation** centers activity at lesser **levels**.

0391

CENTRALIZATION versus DECENTRALIZATION ^{1) - 4)}

According to K. BOULDING: "Centralization produces failure to optimize because of the breakdown of the **communication network**. Decentralization on the other hand produces **suboptimization**, from the point of view of the **organization** as a **whole**, and likewise produces a failure to optimize" (1972, p.88).

It becomes clearer that, in well organized systems, some basic **functions** should be centralized and secondary or local ones, be decentralized. The **model of heterarchical organization** should be helpful in this.

0392

CHAIN REACTION ¹⁾

"A reaction that proceeds in a series of steps with each step being made possible by the preceding one" (UNESCO-UNEP, 1983, p.7).

A chain reaction may lead either to a **run-away** in case of unchecked **positive feedback**, or to **dynamic stability** as for example when a **hypercycle** sets in, or still, to the progressive extinction of the **process** in case of damped **oscillations** leading to a final **static equilibrium**.

0393

CHANCE ³⁾

The characteristic of unexpected, unpredicted or **random events**.

The idea of chance is not much more than a mental crutch, corresponding to our lack of understanding of the generally very complex causes of more or less **random events**. With

the discovery - at least partial - of these complex causes through **chaos theory**, the basic nature of what we call chance has become at least somewhat clearer.

0394

CHANGE ¹⁾

The **transition** from one **state** to another in a system, or from one value of some **variable** to another in a **function**.

Change can be **periodic** or aperiodic; **random** or **determined**; swift or slow (according to some **time scale**); local or global, i.e. affecting some **structure and function**, or the system as a **whole**.

It can also be **cyclical** in a simple or complex way. It may remain channeled within **limits**, or escape from them.

The most radical changes, as stated by I. PRIGOGINE, occur when: "**nonequilibrium macroscopic** conditions create new **microscopic processes** which in turn change the **macroscopic** conditions, and so on" (1984, p.61).

Each type of change is related to some specific cybernetic and/or systemic **behavior**.

The **perception** of change depends on the capacities of our senses, possibly aided by **artefacts**; on our specific training and on the **correlation** between our own **time scale** and the **scale** of change. We are ill equipped to perceive very small or very large change, as well as very swift and very slow ones. As a result we are exposed to be surprised by **delayed** or **mass effects** and **catastrophes**.

0395

CHANGE AGENTS ^{1) - 4)}

Changes do not occur without causal agents, which can be of very different types.

It is important to try to recognize such agents when they are still **potential** or in incipient **activity**, because this is the only way not to be caught by surprise, experiencing negative **effects** or missing opportunities.

Apart from their nature, their ways of acting may give us inklings about their possible **timing** and **effects**. Such a **knowledge** is practically the only way to acquire at least a modicum of **predictive** capacity.

It may also lend us some possibilities to adapt to future changes or even to make a creative use of them when they surface.

J.H. MILSUM observed the importance of change in the **stimuli** as: "...in (their) absence most of the relevant **receptors** generally cease to be stimulated" (1968, p.44). He also notes that, in the long run, the lack of change in **stimuli** may lead to the partial or total impairment of specific **perceptions**.

J.A. JOHANNESSEN and A. HAUAN introduce the notion of a change agent as a specific person in an **organization**, who normally introduce changes, whether technical, organizational or conceptual (1992, p.174).

0396

CHANGE (Forms of)^{1) - 2)}

We do not generally pay much attention to the concept of change and as a result, our evaluations of some changes that we witness are frequently erroneous or out of step with reality.

If we consider change in systems and systemic **processes**, we may establish the following tentative **classification** of its different possible modalities.

- Morphostasis	linear periodical or cyclical (or autopoietic-homeostatic)
- Growth	generally homeorhetic , non linear logistic , or within asymptotic limits in systems already autopoietic , but not yet mature
- Morphogenesis	non-linear without limits viz- logarithmic , exponential , factorial leads to discontinuities ("catastrophes")
- Emergence and Evolution	discontinuity leading to higher level of organization

The correct understanding of the kind of change in a **process** or a system is of paramount importance for better **predictability**.

Moreover some specific type of systems or **processes** change generally depends on the **stability** or **instability** of their **meta** (or **supra**) **system** or **environment**.

Some authors (viz. WILDEN, 1972) seem to understand **morphogenetic** change as cyclically **autopoietic**. Others (viz. WADDINGTON) consider **homeorhetic growth** as **morphogenetic**. Contrarywise ROBB considers that "unexpected degrees of freedom appear" which may lead to "**emergence of order at a higher level... or collapse**" (1990, p.140).

The very basic concept of change is now modified by the recent developments of the theory of **Self Organized Criticality**. P. BAK writes: "Any small **change** of any **event** (Note of the editor: or possibly any different small **event** - or in any case simply any **event**, even small) will sooner or later affect **everything** in the system. If the initial **event** caused a large **avalanche**, the **effect** will take place sooner rather than later" (1996, p.159)

0397

CHANGE (Incremental)→ **Change (Rates of)**

0398

CHANGE (Principle of nonproportional)^{1) - 2)}

"It is impossible for **models** of different **sizes** to possess identical characteristics"

The principle has been enunciated by K. BOULDING (1956, p.66-75), who comments: "As any **structure** grows, the proportions of its **parts** and of its significant **variables** cannot remain constant. It is impossible... to reproduce all the characteristics of a **structure** in a **scale model** of different **size**. This is because a uniform increase in the **linear dimensions** of a **structure** will increase all its areas as the square, and its volumes as the cube... As some of the essential **functions** and **variables** of **structure** depend on its **linear dimensions**, some on its areal **dimensions**, and some on its volumetric **dimensions**, it is impossible to keep the same proportions between all the significant **variables** and **functions** as the system grows.

"This principle has two important corollaries. The first is that **growth** of a **structure** always involves a compensatory change in the relative **sizes** of its various **parts** to compensate for the fact that those **functions** and properties which depend on volume tend increasingly to dominate those depending on length. Large **structures** therefore tend to be "longer" and more convoluted than small **structures** in the attempt to increase the proportion of **linear** and areal **dimensions** to volumes" (p.71).

BOULDING gives interesting examples from biology to insect and human architecture.

"The second corollary follows immediately from the first: If the **process** of compensation for structural disproportion has **limits**, as it seems to be the case, the **size** of the **structure** itself is limited by its ultimate inability to compensate for the non-proportional changes. This is the basic principle for the "law of eventually **diminishing returns to scale**" familiar to economists" (p.72).

This corollary shows that the **analogy** between dinosaurs, business conglomerates and bloated bureaucracies is quite more than a **metaphor**. It also shows how much any type of **organization** would benefit from a better understanding of global **isomorphisms**.

BOULDING still adds: "It is interesting to note that the principle of compensation may operate in two very distinct ways - in the direction of attempt to **solve** the **problems** posed by large **scale** or in the direction of an attempt to **avoid** these **problems**" (p.72).

Of course, the second way is generally much more economical than the first one, since the reduction of an overgrown **structure** is much more costly - when still possible! - than the means usable to avoid its excessive **growth**.

0399

CHANGE (Propagation of)¹⁾²⁾

In complex systems, propagation of change is very difficult to evaluate in real time and still more difficult to forecast.

It is in most cases a **percolation phenomenon** as for ex. in floods or in forest fires. This is so because:

- change can be self multiplying in a **fractal** form, for ex. by the production of flying sparks in a forest fire
- some **parts** of the **environment** are more conducive than others to propagation: sparks can trigger a new focus on a dry place or be extinguished in a pool of water

Such types of **propagation** are very difficult to predict because they affect environments which are similar to **non-homogeneous networks**, with locally different characteristics, which may, or may not brake or accelerate the **process** and, in cases, start secondary sequences of **events** of different types.

These in turn can be multiplicative by **positive feedbacks** or self-limitative by negative ones.

0400

CHANGE (Rates of)¹⁾

Every system and **phenomenon** has its own rate of change, which may even change with **time**.

We still lack a good general systemic theory of rates of changes. This is a gap that needs urgently to be closed.

In particular, the non **perception** of slow change is one of the most dangerous problems for **social systems** endowed with the power to change practically every aspect of their internal **organization** and **interrelations** with their **environment**.

Slow changes result in **large scale effects** whose **accumulation** is slow and insidious and whose reversal may be very difficult. The true importance of this matter is now becoming patent in problems of global climate change or loss of genetic **variety**, for example.

0401

CHANGE (Second Order)¹⁾

A change framed within or brought upon the physical or mental **memory** of former **situations**.

With time, any evolving or **learning** system accumulates **structures**, **functions** and/or **memories**, which do not anymore disappear and become the unavoidable **frame** for future **adaptations**, for which they offer short cuts.

G. BATESON emits the following comment: "The very economy of **trial and error** which is achieved by **habit formation** is only possible because **habits** are comparatively "hard pro-

grammed", in the engineers' phrase. The economy consists precisely in *not* re-examining or rediscovering the premises of **habit** every time the **habit** is used" (1973, p.245)

0402

CHANNEL¹⁾

"The instruments (objects, **events**, and their properties) that produce **transmission**" (R. ACKOFF & F. EMERY, 1972, p.190).

"That part of a **communication** system along which **messages** are conveyed, or its mathematical **representation**" (G. PASK, 1961, p.114).

R. ACKOFF and F. EMERY give the following examples: "In sending a letter, the postal service is the channel, in telephone communication it is the telephone system, and in speech it is the atmosphere" (ibid).

There are numerous different types of channels. Some examples are:

- a telephone wire
- electro magnetic waves of well defined **frequency**
- atmosphere as **transmitter** of sounds
- the operating system within a computer
- defined **paths** within the nervous system

To be transmissible through a specific channel, **information** must be translated into the kind of **signals** proper to the channel. This is done by a sender using a **code**.

The physical **code** to be used should not be confused with the **code** expressing **meanings**. Generally, *both* are needed.

A physical channel has a specific capacity to convey so many **signals** per **time-unit**, as a maximum. The main concern of an engineer is the **choice** of the best possible type of channel corresponding to some **class** of **signals** to be transmitted; the protection of this channel against outside **perturbations (noise)** and, if this is not absolutely possible, calculating the number of repetitions of the **signals (redundancy)** needed to maintain intelligibility.

Of course, this complex **process** of **communication** is used to transmit **information**, but this should be understood in a quantitative sense. For example, a channel may be able to carry so many **bits** per second, when in optimal condition, i.e. noiseless. This is however never possible in any real channel. And, taking **noise** into account, the **transmitter** should allow for so many **bits** of **redundancy** per second. It is in this sense that **information** can be quantified.

0403

CHANNEL and NET^{1) - 2)}

"The **subsystem** composed of a single route in physical **space**, or multiple interconnected routes, over which **markers** bearing **information** are transmitted to all parts of the system" (J. MILLER, 1978, p.3).

This is one of the 20 critical **subsystems** in MILLER's **taxonomy of living systems**. As such, it offers general characteristics for channels and nets and is submitted to the general limitations of the same.

Channel and net appear in a similar way in FORRESTER's **Systems dynamics**.

0404

CHANNEL CAPACITY²⁾

The maximum **rate** (expressed as the number of **information** units per second) at which a channel can transmit **messages** with minimal distortion.

According to C. SHANNON: "If the **source** is of a simple type, releasing **symbols** of equal length (as in the case of a teletype for example), if in this **source** each chosen **symbol represents s information bits** (freely chosen from 2ⁿ **symbols**) and finally the channel may transmit, let us say, n **symbols** per second, the capacity C of the channel is then defined as being ns **bits** per second" (1949).

This is of course a strictly quantitative and numerical **measurement**, once the needed **energy** has been used to create the **signals**. In R.N. ADAMS words: "The channel capacity of a telephone **circuit** refers to the fact that the physical composition of the **circuit** can receive only a finite amount of energetic **activity** over a given **period of time**" (1988, p.84).

0405

CHANNELS (Cost of)¹⁾

Channels for any kind of **communications** must be constructed and maintained. H. ODUM states: "The many channels required to make the special chemical and physical **structures** for maintaining ordered **networks** take much work and therefore much **metabolic energy**" (1971, p.98).

This is also true for non-biological systems, as may be observed in any human **organization**.

0406

CHAOS^{1) - 2) - 3)}

"The irregular, unpredictable **behavior** of **deterministic nonlinear** systems (R. JENSEN - 1987, p.168).

"The operation **mode** of persistently unstable systems" (after B. JONES, 1994).

This **meaning** of the term "chaos" was introduced by J. YORKE, of Maryland University (1975).

It is not possible to develop, even sketchily, the concept of chaos in this dictionary, basically because:

- 1) it is highly complex with broad mathematical development
- 2) it is still in the making

According to A.B. CAMBEL, chaos theory is "a heterogeneous amalgam of different techniques of mathematics and science. Systems that upon analysis are found to be **nonlinear**, **nonequilibrium**, **deterministic**, **dynamic** and that incorporate **randomness** so that they are sensitive to **initial conditions**, and have strange **attractors** are said to be chaotic" (1993).

J. GLEICK introduces chaos in the following terms: "To some physicists chaos is a science of **process** rather than **state**, of becoming rather than being...

"Chaos breaks across the lines that separate scientific disciplines. Because it is a science of the global nature of systems, it has brought together thinkers from fields that had been widely separated...

"Chaos poses problems that defy accepted ways of working in science. It makes strong claims about the universal **behavior** of **complexity** (1987, p.5).

As to its real importance, GLEICK comments on R. MAY opinion: "Chaos should be taught, he argued. It was time to recognize that the standard education of a scientist gave the wrong impression. No matter how elaborate **linear** mathematics could get, with its **Fourier transforms**, its orthogonal functions, its regression techniques, MAY argued that it inevitably misled scientists about their overwhelmingly **nonlinear** world: "The mathematical intuition so developed ill equips the student to confront the bizarre **behavior** exhibited by the simplest of discrete **nonlinear** systems" he wrote.

"Not only in research, but also in the everyday world of politics and economics, we would all be better off if more people realized that simple **nonlinear** systems do not necessarily possess simple dynamical properties" (p.80).

The chaos **concept** is an important part of a new **set** of mathematical theories at present in process of build-up. It is more or less closely related to **catastrophe theory**, **stability** theory, **fractals**, a renewal of the **concept** of **cycle**, general **topology**, **thermodynamics of irreversible systems far away from equilibrium** and **criticality** and **percolation theory**.

It has led to a deep questioning of the traditional - and absolute - notions of **determinism** and **randomness**. Formerly, in the words of GLEICK: "Either **deterministic** mathematics produced **steady behavior**, or **random** external **noise** produced **random behavior**. That was the choice.

"In the **context** of this debate, chaos brought an astonishing message: simple **deterministic models** could produce what looked like **random behavior**. The **behavior** actually had an exquisite fine **structure**, yet any piece of it seemed indistinguishable from **noise**" (p.78-9).

Also J. CASTI emphasizes: "Scientifically speaking, chaos is only the appearance of **randomness**, not the real thing" (1994, p.88).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

I. EKELAND, in turn, cites MAXWELL: "It is a metaphysical doctrine that the same antecedents always produce the same consequents. Nobody could deny it. But it is of reduced usefulness in a world like this one, where the same antecedents can never be found and where nothing recurs twice... The physical axiom which looks alike is that similar antecedents produce similar consequents. But here we changed from exactness to **similarity**, from absolute precision to a more or less crude approximation" (1984, p.85).

Chaos definitely puts an end to LAPLACE's Clockwork Universe and, altogether, to the age old dream of absolute **predictability**.

In any **complex system**, and at any moment, there is a new set of **initial conditions**. This leads to the practical impossibility of definite evolutive **forecasts**, as possibilities relentlessly open up at any future **time** and the internal **correlations** of the system become reduced. The only **invariance** is a global **enveloppe embedding** many possibilities as no future **transformations** can escape the historical development of **archetypes**.

From another viewpoint, as stated by Chr. VIDAL: "...the **strange attractor concept**, while undoubtedly broadening the recognized domain of **determinism**, simultaneously establishes on quite more strong bases the need to resort to statistical methods... now imposed by the very logic of mathematics" (P. BERGÉ et al., 1984, p.288).

It should at last be recognized that "pure" **determinism**, as well as "pure" **randomness** are merely ideal limit cases of all possible **behaviors** of systems, corresponding, the first to strictly **lineal** systems and the second to completely degraded **order**.

As observed by E. LASZLO: "Chaos is not the opposite of **order** but its refinement: it is a subtle, complex, and ultrasensitive form or **order**" (1992, p.243).

This is probably the reason why science started to discover it just one century ago (POINCARÉ's **three bodies problem**) and to explain it no more than 30 years ago (E. LORENZ).

0407

CHAOS (Anti-) ¹⁾

A property of "some very disordered systems (which) spontaneously *crystallize* into a high degree of **order**".

Such "very disordered systems" seem to contain implicate **order**, through the **nonlinear interactions** between a number of different **simultaneous** types of **behavior** within the system. These result in a very complex global **determinism** at such a very **long term time horizon** that it either cannot be observed, or becomes deeply transformed in **time** by **perturbations**. See "Prime numbers" and "Three Bodies Problem".

"However, in some cases, these **nonlinear interactions** become associated in such a way as to generate a strongly unifying and self-maintaining **pattern**. **Solitons** are good examples of this kind of **self-organization**.

According to J. BRIGGS & F. DAVID PEAT (1989), **solitons**, very far to be only a rare and curious hydrodynamic **phenomenon**, as for example giant waves that sometimes appear in oceans, would be a very general one, even in biological systems and in nervous transmission.

0408

CHAOS (Centre for Hyperincursion and Anticipation in Ordered System) ¹⁾

This Centre, based at the Institute of Mathematics, University of Liège, Belgium, is focusing its activity on **anticipatory processes** and systems, in a **transdisciplinary** spirit.

Its founder and mentor, Prof. Daniel Dubois, writes: "Anticipation is not only a property of biosystems, but is also a fundamental property of physical systems. In electromagnetism, the **anticipation** is related to the Lorenz transform. In this framework, the anticipation is a strong anticipation because it is not based on a prediction from a **model** of the physical system, but is embedded in the fundamental system".

In fact, the proceedings of the yearly meetings of the CHAOS Centre (organized since 1997) show a widely embracing **transdisciplinary** viewpoint. Published papers include not only general concepts and **models**, but also anticipatory studies related to biological systems, psychology, psychiatry, **linguistics**, economics and **social systems**.

Papers also consider modelling means as **neural networks**, **genetic algorithms**, **automata**, **holograms**, **fractals**, etc.

The Centre publishes its "CASYS- International Journal of computing Anticipatory Systems"

More information can be obtained at the page: <http://www.ulg.ac.be/mathgen/CHAOS/CHAOS.html>

0409

CHAOS (Computability of) ⁵⁾

According to R. JENSEN: "Another manifestation of the **unpredictability** of **chaotic dynamical systems** is that the time-evolution is computationally irreducible. There is no faster way of finding how a **chaotic system** will evolve than to watch its **evolution**. The **dynamical system** itself is its own computer" (1987, p.179).

However, we can nevertheless compute reliable odds or probabilities for the outcome of these **processes** (i.e. for example football, or soccer games or turbulent flows). As a conse-

quence probabilistic and statistical theories provide a natural **description** of average properties of **chaotic systems**".

"... Since simple **models** can yield complex, irregular **behavior**, we can actually hope to develop theoretical **descriptions** of a wide variety of apparently **random**, unpredictable natural **phenomena** using mathematical **models** which exhibit deterministic **chaos**" (Ibid).

Hence, the paradoxical situation appears wherein **determinism** can be partly described from a **random** base, but never in a such precise way as to allow for rigorous **prediction**.

0410

CHAOS (Control of) ^{1) - 2)}

E. OTT and M. SPANO showed that, while "the extreme **sensitivity** and complex **behavior** that characterize **chaotic systems** prohibit long-range **prediction** of their **behavior**", they "paradoxically allow one to **control** them with tiny **perturbations**" (1995, p.34).

They explain this **stabilization process** as follows: "The **periodic** orbits embedded in a **chaotic attractor** are all unstable in that if one displaces the system **state** slightly from a **periodic** orbit, this displacement grows exponentially with **time**. Thus **periodic** orbits are typically not observed in a free running **chaotic system**". However: "Very infrequently a **chaotic** orbit may, in its **ergodic** wandering, approach close to a given **periodic** orbit. If this happens, the orbit may approximately follow the **periodic** orbit for a few **cycles**, but subsequently moves away, resuming its wandering over the **chaotic attractor**".

The **control** problem consists in stabilizing these "wanderings" near some selected **periodic** orbits. To do this the authors state: "We tailor our small **time-dependent controls** in such a way as to stabilize one of the **unstable periodic** orbits that yields improved **performance**" (p.35-6).

In this way, the **ergodic** character of the system could be to some extent reduced. (For technical details see this very suggestive paper).

The experimental research, to date, shows the feasibility of chaos control. The authors conclude: "The remaining question is whether it will prove possible to move from laboratory demonstrations on **model systems** to the real-world **situations** of economics, engineering and societal importance. The ubiquity of **chaotic dynamics** leads us to suspect that this will indeed be the case" (p.40).

The other remaining question is however if meddling with **naturally chaotic systems** would necessarily be wise. The **rhythm** of the heart pulses for example has been proven to be normally slightly **chaotic**, possibly as this implies **adaptive variety** to internal and external **disturbances**. We are in problems when this **rhythm** becomes too narrowly and regularly

periodic. We should beware not let ourselves entrapped in our classical **semantics**, according to which **chaos** is "bad" or "scandalous" in itself.

→ **Chaotic system (Stabilization of a)**

0411

CHAOS (Deterministic) ^{1) - 2)}

Unpredictability in a globally deterministic system.

Systems affected by deterministic chaos are **nonlinear** and have a high **sensitivity to initial conditions**.

Generally speaking, **predictability** is (more or less) possible at global **level** and impossible at local ones.

It also swiftly diminish into the future. However "... recent developments in **self-organization models** and **nonlinear thermodynamics** have attracted attention to the opposite **phenomenon**: microscopically **deterministic** systems that behave in a completely **unpredictable** way when considered from a macroscopic viewpoint. Examples are the so-called "deterministic chaos" and certain types of **cellular automata** whose local dynamical **rules** are completely **deterministic** but for which there is no global **algorithm** allowing to predict their overall **evolution** without computing all the individual, microscopic **transitions** from the given **initial state**". (F. HEYLIGHEN, 1989, p. 378; also S. WOLFRAM, 1984).

However, these systems are only globally (but not "completely") **unpredictable**: they would have a global **vicinity of behavior**, at least until a **bifurcation** makes them cross a **stability threshold**, changing their nature by **emergence**, or destroying them.

According to P. DAVIES: "...the study of chaos has revealed how it is possible to reconcile the **complexity** of a physical world displaying haphazard and capricious **behaviour** with the **order** and simplicity of underlying laws of nature" (1990, p.51).

However: "The key feature of a chaotic **process** concerns the way that predictive **errors** evolve with **time**" (ibid., p.49), i. e. the way they rapidly increase and practically destroy **predictability**".

0412

CHAOS (Edge of) ²⁾

A **threshold** zone of complex **dynamics** unstably balanced between determined **order** and chaos.

R. LEWIN, in his review of St. KAUFFMAN's book "The Origines of Order" explains: "This poised state... offers rich possibilities for computation in mathematical **models**. KAUFFMAN draws on these principles and develop rich im-

ages and cogent mathematical **descriptions** how they might operate within biological systems. Life, he suggests, exists on the edge of chaos" (1993, p.46).

Emergence of higher **levels of organization** seems possible in dynamical **situations** freed from rigid **order** of controlled **stability** where **behavior** may become "most flexible, complex and adaptable" (ibid).

0413

CHAOS (Free will and) ^{1) - 3)}

J. CRUTCHFIELD et al. state: "Innate **creativity** may have an underlying chaotic **process** that selectively amplifies small **fluctuations** and molds them into macroscopic mental states that are experienced as thoughts. In some cases the thoughts may be **decisions** or what are perceived to be the exercise of will. In this light, chaos provides a mechanism that allows for free will within a world governed by **deterministic laws**" (1989, p.49).

This hypothesis could be well grounded if the **brain's neuronal nets** are the seat of **chaotic processes**. (This subject would justify a thorough investigation). It would be the case if various interconnected **subnets** should simultaneously show independent **periodic oscillations** whose **frequencies** would not have a common divisor.

As to "**deterministic laws**" it is now obvious that the **meaning** of the word "**deterministic**" direly needs a careful revision, precisely in the case of chaotic **behavior** in **complex systems**: **determinism** is not abolished, but it becomes relativized in a way which is not yet quite clear.

0414

CHAOS: Historical meaning ¹⁾

Originally a greek word meaning chasm, abyss. This derived toward meanings like undifferentiated, confused, disordered, shapeless.

E. SCHWARZ, in his "Systemic Glossary" (in french) states "Chaos: Initial unorganized state of the world in Hesiod's cosmogony (8th b.C.) in which is it nevertheless possible to recognize the primeval dyad Gaia and Ouranos, as well as the primeval Eros, the dynamical principle" (1993, p. 2)

Curiously this type of chaos never went away from human minds. Its more recent expressions are the Big Bang and its first moment "inflation", or the recent resurgence of the aether as the locus of materialization of paired particles (positive and negative) out of ...a "something-nothing"

→ **Entelechy**

0415

CHAOS (Onset of) ²⁾

P. BERGÉ and M. DUBOIS describe three different ways leading form a **periodic behavior** to a chaotic one:

- By **period doubling**, where the basic **period** is multiplied by 2 at each **bifurcation**, until an infinite **period** is approached;
- The **intermittences** scenario, in which the **periodic states** become slowly disorganized until suddenly exploding into **turbulence**;
- The quasi-**periodicity** scenario wherein the **nonlinear interactions** of 2 or 3 **oscillators** lead to **chaotic behavior**. (1992, p. 128).

→ **Ergodicity**

0416

CHAOS (Weak) ^{1) - 2)}

Characteristic of a **composite system** which "evolves on the border of chaos" (P. BAK & K. CHEN, 1991, p.32)

These authors state: "This **behavior**... is a result of **self-organized criticality**. Weak chaos differs significantly from fully **chaotic behavior**. Fully **chaotic systems** are characterized by a **time scale** beyond which it is impossible to make **predictions**. Weakly chaotic systems lack such a **time scale** and so allow **long term predictions**" (p.32).

This seems somehow debatable. From one part so-called "full chaos" seems to maintain for extremely long periods a measure of global **determinism**. On the other hand, even on base of a known **flicker noise** some **uncertainty** (growing with **time**) always remains as to when a **runaway event** or **percolation process** may appear. It must be conceded however that a stock market or a **population crash** is creating the conditions that impede another stock market crash or population crash. The **percolation event** destroys the global **cluster** that it has built... but leaves open the possibility of reconstruction of another **cluster**.

Compare with "**ergodicity**"

0417

CHAOTIC DYNAMICS

→ **Dynamics (Chaotic)**

0418

CHAOTIC SYSTEM ¹⁾

J. BRIGGS and F.D. PEAT state: "Chaotic systems are locally unpredictable, but globally stable" (1991, p. 74). They give the now classical example of climate.

According to K.B.DE GREENE (1990, p.52), who quotes R.L. DEVANEY (1987): "... a completely chaotic system (is) one that is **unpredictable** (highly dependent on **initial conditions** that greatly reduce the accuracy of numerical study), indecomposable (the system cannot be broken into **subsystems**), and recurrent (producing **periodic orbit**). These features correspond to physical systems that show **turbulence**"

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

And: "... systems (may) not be completely chaotic and may show limited windows of chaos. In systems **evolution** chaos and **turbulence** may well be prerequisite to **structural change**".

These concepts are also applicable to **eco-systems** and **sociosystems**.

→ **System (Ergodic)**

0419

CHAOTIC SYSTEM (Stabilization of a)²⁾

According to Ed. OTT et al. (1990, p.1196), as quoted by D. BROOMHEAD, a chaotic system can be stabilized, at least in the absence of other uncontrolled effects as for example genuine **noise** "... by repeated application of small **perturbations**, in a **state** which approximates the chosen **state** to within a preset **error**. By keeping the **error** small, the magnitude of the **perturbation** is correspondingly kept below a **threshold p****" (1990, p.23).

However, this is possible only "... when the chaotic wandering has brought the system sufficiently close to the center C (of the **saddle** of the **attractor**). It is property of the **chaotic attractor** that this will happen after an unknown but finite **time t**" (Ibid.).

→ **Chaos (Control of)**

0420

CHEMOTAXIS⁵⁾

"A **phenomenon** whereby a chemical released in the system attracts or repels a **population of cells or organisms**" (I. PRIGOGINE, P.M. ALLEN and R. HERMAN, 1978, p.40).

Chemotaxis is a **socialization** factor, in the same class as pheromones in social insects. It induces a kind of spatial **anisotropy**, as for example in the amoeba *Dictyostelium discoideum*, whose **aggregation** is controlled by the **level** of adenosine triphosphate (AMP) secreted by the **cells**. It is also operating in the construction of the nervous system, as shown by the recent discovery of so-called netrin proteins, which guide the growth of axons, by a team under the lead of M. TESSIER-LAVIGNE (Scientific American, Jan. 1995). The establishment of this type of spatial **gradient** is quite a general **phenomenon**. It corresponds probably to some not yet discovered similar one in human crowds showing collective nonrational **behavior**, yet to be explained.

0421

CHESS AS A DESTRUCTIVE DYNAMIC GAME^{2) - 5)}

A. LOTKA stated as early as 1924 the basic characteristics of chess as a systemic **game** and described them as follows:

"The elements that determine the course of the **game** are as follows:

1. A topographic map, a chart of geometric **constraints**, the chess board.

2. Movable upon this chart, a number of movable points (chessmen), each the **center** of a **field of influence**, defined for each movable point in relation to the geometric **constraints**. So, for example, the field of influence of a pawn extends to the two squares diagonally in front of the pawn.

3. A law restricting the **time-rate** of advance of each moving point (moves alternate from white to black).

4. A law defining the influence upon each other of two points in **collision**, i.e., two points whose fields of influence have interpenetrated to a prescribed extent. An example of this is the **rule** that a chessman arriving upon a square occupied by a hostile piece, throws the latter off the board.

5. A law restricting the movements of the points when not in collision, i.e., when outside one another's field of influence. So, for example, a bishop may move only diagonally.

6. The elements enumerated so far place **restrictions** upon permissible changes (moves). These elements alone cannot, evidently, **determine** any occurrence of any kind. Absolute immobility, for example, or any **random** move that did not violate the **rules** of the **game**, would equally satisfy the conditions enumerated.

7. In addition to the elements 1,2,3,4,5, there must therefore be in operation some positive principle (tropism) which not merely restricts possible occurrences, but which determines actual **events**. In chess this principle is furnished by the effort of each player to bring about checkmate" (1956, p.343).

A similar analysis could be made of the **game** of GO or the **games of life** of J. CONWAY. **Similar rules** were also proposed by M. MARYAMA in his **2nd Cybernetics**.

All these **games** could be very useful for the study of the **transformations** of numerous natural and artificial systems based on different **rules**... and for aiding man to become a better chess player on the planet's chessboard!

0422

CHINA IN SYSTEMS SCIENCE¹⁾

The Chinese Institute of Systems Sciences is established in Beijing.

Under the leadership of Prof. GU JIFA and in collaboration with the Centre for Systems Studies at the University of Hull (UK) a first International Conference was organized in Beijing in 1995. The conference was supported by the National Science foundation of China.

Scholars from China, Japan and the United Kingdom took part in the event and the Proceedings have been published at the University of Hull under the editorship of Gerald MIDGLEY and Jennifer WILBY.

This event signaled in fact the effective entry of the Chinese systemists in the international systems community.

In August 2002 the forty sixth Meeting of the ISSS took place at the Tong Ji University Business School in Shanghai, again in connection with the Univ. of Hull Business School. Prof. Mike Jackson, President of the IFSR and Professor at Hull and Dr. ZHICHANG ZHU were Programme Organizers co-chairmen

0423

CHINA-JAPAN-UK. Systems Project¹⁾

A group of systems researchers from China (JIFA GU and ZHICHANG ZHU), Japan (YOSHITERU NAKAMORI) and the UK (M. JACKSON and other Hull University scholars) initiated this cross-cultural learning and integration systems project in 1993-94.

From 1995 to 2001, five project conferences and workshops have been held in China, Japan and the UK., and cross-visits organized.

A detailed report about respective approaches, methodologies and application areas and specific projects has been published in "Systems Research and Behavioral Science", vol. 19 (1), 2002

0424

CHINESE SYSTEMS CONCEPTS AND METHODOLOGIES¹⁾

The authors describe as follows the concepts in Chinese thinking that form the basis of a Chinese systems methodology: "The basic theme of Wuli, Shili and Renli contends that *wuli* (regularities in objective existence), *shili* (ways of seeing and doing) and *renli* (patterns underlying human relations) constitute a differentiated whole that conditions systems projects. WSR suggests that we should design and employ appropriate methods to address and tackle *wuli*, *shili* and *renli* elements in a theoretically informed and systemic way" (2000, p. 11)

"Such relational philosophies also suggest that the Tao (**morality**), Zhi (**knowledge**) and Xing (**action**) of human beings are systemically conditioning and supporting one another and, therefore, cannot be "artificially" isolated from one another" (Ibid, p. 12)

There is of course much more to it and the subject deserves close attention from systemists in general.

The whole of first issue of volume 13 of SPAR is dedicated to Chinese systems concepts.

→ **China in systems science; Wuli; Shili; Renli**

0425

CHIRALITY^{2) - 5)}

The complementarity but opposed **symmetry** of forms.

The term, derived from the greek language, alludes to the opposed **symmetry** of the hands ("Kheir" = hand in Greek)

An example are levogyre and dextrogyre tartaric acid crystals, an opposed **symmetry** discovered by PASTEUR. Chirality is also very common in **living systems**. It seems to be a quite basic natural feature, somehow related to **symmetry-breaking**.

→ **Enantiomers**

0426

CHLADNI FIGURES ²⁾ - 5)

Patterns obtained by spontaneous ordering of powder or sand on a metallic vibrating plate.

The powder gathers at the nodal lines and materializes the **distribution** of the **energy** induced on the plate by the source of vibrations. Many different **patterns** can be obtained according to the type of powder used.

A historical antecedent was DESCARTES' magnetic phantom. C. LAVILLE also mentions GUEBHARD experiences showing the possibility to materialize KIRCHOFF's diagrams of equipotential lines of forces in a **field** through electrolytic deposition. Many different figures can be obtained. It is surely not a coincidence if many of these diagrams show **structures** quite similar with natural **forms** in **living systems** (For example butterfly wings, bone **structures**, protozoaria, etc...), and also very fundamental **processes** as in the egg's progressive division in embryology. Structural engineering as for example in bridges materializes the same types of **forms**.

For many stimulating developments related to the close relations between **energy flows**, **processes** and **structures**, see d'ARCY W. THOMPSON (1916; 1952) and C. LAVILLE (1950).

0427

CHOICE ¹⁾

The possibility of **selection** between two or more future possible **situations**, or **programs** of **action**.

The **concept** of choice is controversial because it implies at least a partial relativization of **determinism**.

According to P. VENDRYES, only regulated systems with available **reserves** and specified **goals** have such **selection** possibilities at any moment.

Choice is thus not merely a result of **indeterminacy** "à la HEISENBERG". Its relation with **chaotic determinism** and eventual **control** of the same should be explored.

(see D. BROOMHEAD - Physics World 1992)

0428

CHOICE as a systemic topic ¹⁾ - 4)

From the systemic viewpoint, choice is a very complex topic.

According to R.L. ACKOFF and F. EMERY, in a **situation** of choice a **subject** has to decide between various (or at least two) possible courses of **action**, affected with different probabilities (1972, p.146).

As a rational election among options, it thus supposes a good understanding of the nature, the needs and the **situation** of the system which is to make a choice.

However, what is understood as rationality refers solely to the logical aspect of choice, while a systemist must also take in account psychological, social and cultural aspects in their most ample sense. In G. VICKERS words: "... choice involves **valuing**, and **valuing** is by implication excluded from the rational **process**. No calculus can compare the relative values of atom bombs and medicare" (1957, p.64).

He could have added that, even if such a calculus could be made in economic or financial terms, for instance, such a problem is never put in that kind of mental **frame**.

In particular, collective choice is a matter of cultural **consensus**, in most cases neither logical or economic.

For the systemist, the problem of choice is thus multi-dimensional.

0429

CHOICE (Random) ²⁾

An arbitrary **selection** among a number of possibilities.

When some new **design**, or device or **behavior** is to be established and there is no obvious advantage of one type in relation to others, the choice is in some cases arbitrary, i.e. more or less left to **chance**.

Historical examples are right hand traffic in some countries and left hand one in others; or the use of the qwerty or the azerty keyboard in different countries.

However, once the **decision** has been taken, it starts to act as a **constraint**, orienting techniques and behavior in an ever more **deterministic** way. This is because any different way to construct devices or to organize behavior would provoke costly incoherences, squandering of **resources**, losses and finally disruptive **conflicts**. This **process** can only be modified or suppressed through a very deep innovation and, in many cases, a stressful **behavioral adaptation**.

In economy, it has been described as "**path dependence**" (B. ARTHUR, 1994)

This is the specifically technical or behavioral aspect of a much more general random choice **process** described by E. ODUM.

0430

CHOROPLETH ⁵⁾

A line of uniform value in a graphical **representation**. (M. CHISHOLM, 1975, p.62).

Choropleths are used to coordinate series of **observations**, corresponding to some specified areas, for example **population density**, or land-use proportions. They allow for the characterization of areas and comparisons between various ones in which different conditions can be summarized, i.e. allow for the **emergence** of a global meaning for collections of specific **data**.

→ **Hexagonal spacefilling**

0431

CHREOD ²⁾

"A canalised pathway of **change**" (C. WADDINGTON, 1977, p.140) or...

"A canalized **trajectory** which acts as an **attractor** for nearby **trajectories**" (WADDINGTON, 1975, p.22).

C. WADDINGTON explains: "... the name chreod, a word derived from Greek, ... means 'necessary path'".

"I have coined the word "chreod" for what is really a characteristic of an **attractor** surface in a multidimensional **space**" (1976, p.245).

He also states: "Different canalised pathways or chreods may have rather different types of **stability** built into them. These can be pictured in terms of the cross-section of a valley. You may for instance, have a valley with a very narrow chasm running along the bottom, while the farther up the hillside you go, the less steep the slope; with such a **configuration** of the **attractor** surface, it needs a very strong push to divert a stream away from the bottom of the chasm... If the system is acted on by only minor **disturbances**, it is likely always to stay very close to the bottom of the valley" (1977, p.140).

This type of **situation** corresponds to **dynamic stability**.

"In contrast, (if) we have a valley which has a very flat bottom... then, minor **disturbances** can easily shunt the stream from one side of the flat valley bottom to the other" (ibid).

This is still **dynamic stability**, but with more potential **fluctuations amplitude**.

In case of very strong **disturbances**, the system may escape from the chreod, in which case **instability** sets in and the system crosses over into another **domain of attraction** (or **stability**), or undergoes **dissipative structuration**, which will transform its very nature, or still, is destroyed.

It is interesting to note that normal **growth processes** in systems are chreodic, which is well in accordance with their **organizational closure**.

0432

CHREOD (Archetypal) ¹⁾ - 2) - 4)

An hypothetical organizing **pattern** that insures the conservation of the basic characters already acquired through **evolution**.

Ch. SMITH resumes this concept, also due to C. WADDINGTON (1975) as follows: "WADDINGTON... proposes that a similar **deep structure**, one that remains intact even during a complete mutation, must be present in living **organisms** to insure that **evolution** rather than devolution, comes about during mutation **processes**. He argues that mutations frequently involve a breaking down of an **order** that **organisms** have been building up through **adaptive processes**. Given that this breaking-down of **order** does occur during mutation, and most species go through mutations (especially in the development of their life supporting **sub-systems**), WADDINGTON argues that the present **states** of development and **order** found in **living systems** would be highly improbable without some other factor coming into play. He argues that some mechanism must be present to insure that mutation does not **reverse evolution**, destroying the degree of sophistication that the system has previously attained. He call this organizing **pattern** an *archetypal chreod* (WADDINGTON, 1975, p.200), seeing it as similar to a **function** or a blueprint. The *archetypal chreod* provides the mutating **organism** with a line of development consonant with its state of accumulated, evolutionary **learning**" (1986, p.208).

This concept seems to be valid for pre-biotic systems, as well as for **social** and even **abstract systems**. C. BRESCH studies this same mechanism in his book about general **evolution** (from pre-biotic to human) and states that a general **catalytic effect** is at work at least from the atomic level on: "**Structures** influence directly the shaping of new **structures**. This potential influence, that amplifies constantly, will lead us all along in this study". (1977, as retranslated from the spanish traslation).

The concept is also clearly related to the **stigmergy** one and there are probably *archetypal chreods* at work when new societies are born as well as new **languages** or even new mathematical concepts.

0433

CHRISTMAS TREE EFFECT¹⁾

The confusing effect on **perception** of numerous and simultaneous **stimuli**, specially visual.

This effect is fast becoming a very serious **risk** factor in control rooms (industrial, nuclear, etc...) or in front of complex panels of instruments as in an aircraft.

The main causes of the Christmas tree effect are:

- The growing **complexity** of **machines** whose totality is now very difficult to grasp by an **operator**
- The swiftness of technology **evolution** which does not allow anymore for sufficient re-adaptive **learning** and imprinting time

- The passage from a concrete **man machine system** interaction to an abstract interaction in terms of massive symbolic **representation**.

In other words, man seems to come closer and closer to the **limits** of his capacity of **perception**, at least in real time, in front of his own **artifacts**.

0434

CHRONOCENTRISM¹⁾³⁾

A tendency to explain **facts** of the past in terms of contemporary **beliefs**.

The archeologist Timothy TAYLOR gives a typical example: As "many archeologists see...a widespread signature of cannibalism across different continents, in different frames, another group of archeologists start to say: "Well, there must be other explanations- because humans don't do this" (Interview New Scientist, sept.28, 2002, p. 48)

While "**anthropocentrism**" and "**culturocentrism**" are well recognized as a source of dubious **interpretations** in human sciences, there is scant perception of the psychological and socio-cultural differences in former societies. A good example is our deeply seated uneasiness about witch hunting in western societies, a **behavior** that was considered normal to our forefathers, of which some may even have been witch hunters...or "witches."

0435

CHRONOTOPE²⁾³⁾

The **space-time framework** of natural systems.

This neologism is stated by Rafael RODRIGUEZ DELGADO in his last work (1997, p.38). He uses the **concept** in social sciences as well as in physical ones, as a way to avoid a partialized view of, mainly, **human social systems** in their historical **dimension** (p.40).

0436

CHRYZODES²⁾

Geometrical representations of numbers and their arithmetic relations.

Chryzodes have been introduced by J.P. SONNTAG (1994, p. 373-378). Chryzodes are graphical **mappings** in two dimensions of series of numbers obtained by arithmetic operations (addition, subtraction, multiplication, etc.)

The mapping is done within a graduated circle and produces what the author calls a "**cybernetic of forms**". A very high level of **complexity** emerges in the figures.

SONNTAG observes that chryzodes are not **fractals**. Their deeper **meaning** and possible uses remain unclear, but they are curious and attractive.

0437

CHUNKING²⁾

The subdivision of a system into significant fragments.

As **subsystems** possess by themselves a **structural** and **functional** specific value, a system should not be arbitrarily "chunked", as expressed by H. SIMON (1974).

K. KRIPPENDORFF gives an interesting example of **information** chunking in telephone numbers, where specific "prefixes" like 54, or 54.214 are given a specific **meaning** allowing for a significant geographic ordering of telephone numbers, wordly and within a given country (1986, p.11).

0438

CINDYNICS⁵⁾

A discipline that studies the laws of danger (from the greek "kindunos": danger)

Most of the dangerous situations do show the following characteristics:

- they correspond to **transformations** in **complex systems**;
- these **transformations** are frequently quite sudden;
- they are very generally unexpected by witnesses, protagonists or victims;
- they cannot be forecasted by simple **linear** extrapolations.

The laws of cindynics should be investigated in close connection with systemic and cybernetic **concepts**, most specially those about:

- **non-linear growth** and **positive feedbacks**
 - discontinuities (or "**catastrophes**")
 - **dissipative structuration**
 - **instability thresholds**
 - **limits to forecasting**.
- "**Disasters**"; Failure tree; Lusser theorem; Petri net; Reliability

0439

CIRCADIAN RHYTHM⁵⁾

Any **periodic behavior** in **living systems** synchronized with the alternance of day and night.

Circadian rhythms are of cardinal importance for all **living systems**, specially human systems up to the highest societal **level**. Recent research by J.S. TAKAHASHI and M. HOFFMAN (1995, p.158-65) pinpointed J. MILLER's **timer subsystem**, which is ultimately located in the suprachiasmatic nucleus (SNC) in mammalian brains. The SNC is apparently heir to the pineal eye of reptiles. It acts as a "master circadian clock" that commands **time-connected activities** and seems to be ultimately under the **control** of a specific gene, or group of genes, since the **activity** rhythms of mice has been altered by induced genetic mutations.

It is moreover interesting to observe that any animal possesses **organizationally closed** devices at the physiological **level**, responding in precisely specific ways to **environmental stimuli**. The case of vegetals, not yet much researched until now, seems to be similar.

0440

CIRCUIT (Causal)^{1) - 2)}

A circuit which "will generate a **non-random response** to a **random event**" (G. BATESON, 1973, p.380).

BATESON emphasizes that this will happen "at that position in the circuit at which the **random event** occurred" ... and adds: "This is the general requisite for the creation of **cybernetic** restraint in any variable at any given position". (Ibid)

ASHBY's concept of **constraint** is obviously synonym of BATESON's one of restraint.

The causal circuit as a **cybernetic** device "will be activated by changes in **rate** and..., when activated, will operate upon some **variable** ... in such a way as to diminish the change in **rate**" (Ibid).

The notion of causal circuit introduces necessarily the system's view and, moreover, the dynamic dimension of systems.

W.R. WINBURN puts it as follows: "(logical dilemma, like the Epimenides **paradox**) arise from the inability of logic to consider **time** in the **description** of a **causal process**. When **time** is not considered, the ability of a circuit to issue opposite **responses** to identical **stimuli** presents a contradiction. The difference between the **description** of a **linear causal process** independent of **time** and a **description** of a causal circuit in which **time** matters is analogous to a difference of **logical type**. The **time-dependent behavior** of circuits forces us to abandon the **level** of individual **parts** and see instead a "system" that responds as a **whole**" (1991, 559).

0441

CIRCUIT (Closed)^{1) - 2)}

A **loop** in which "... causal interconnection can be traced around... and back through whatever position was (arbitrarily) chosen as the starting point of the **description**" (G. BATESON, 1973, p.380).

BATESON adds: "In such a circuit, evidently, **events** at any position in the circuit may be expected to have **effect** at *all* positions on the circuit at later **times**. Such systems are always *open*: a) in the sense that the circuit is energized from some external **source** and loses **energy** usually in the form of heat to the outside; and b) in the sense that **events** within the circuit may be influenced from the outside or may influence outside **events**" (Ibid).

0442

CIRCUITS (Degenerative - Regenerative)^{1) - 2)}

A circuit may be either degenerative or regenerative, according to the type of **feedback** it includes.

A regenerative circuit, i. e. one including a **positive feedback** (as stated by G. BATESON): "... (will) if provided with the necessary **energy sources** and if external factors permit,... clearly operate at a greater and greater **rate** of intensity" (1973, p.81).

Such a **process** may of course put it on a self-destructive **path** if no **negative feedback** intervenes in due **time**.

On the contrary, a **negative feedback**, if not timely compensated by a positive one, will progressively **dampen** the system's **fluctuations** and may well finally block it.

0443

CIRCULARITY^{1) - 2) - 3)}

Character of any self-repeating **process**.

In order to take the **time-dimension** in account it would be more advisable to speak of "spirality".

Circularity is the result of **feedbacks**, specially the **cyclical** ones, corresponding to alternative positive and negative action, or **on-and-off processes**.

The circular **process** is essentially **self-referential** and basic for **recursivity**. It is generally functional and tends to generate either an **algorithm**, or a **structure**.

A degree of (frequently hidden) circularity is unavoidable in reasoning: St. KAUFFMAN, quoting W.V. QUINE, considers that "no hypothesis confronts the "world" alone. Instead, it confronts the world as part of an entire worldview of linked hypotheses plus statements about the experimental **situation**. Given a negative experimental result, something must be rejected. Either some hypothesis is wrong, or a **description** of the experimental **situation** is incorrect. But, as Quine pointed out, the **choice** of which hypothesis to reject is a *free one*. ... Different **choices** of which hypothesis to reject impinge on the whole web of hypotheses and laws. To maintain **coherence** in that web, we typically choose to salvage a central circularly interdefined **cluster** of hypotheses" (1993, p.17).

This situation appeared repetitively in science since the nineteenth Century: Non-euclidean geometries, corpuscular and undulatory theories of light propagation, quanta, relativity, **chaos**, etc...

As to **recursivity**, it corresponds to von FOERSTER's "**Eigen-**" **concept**, and to conceptual **closure**.

R. GLANVILLE observed that circularity is of utmost importance in **conversation** in G. PASK's sense, because it is : "...the basis for **understanding**, for the world as we (are) now seeing it, and for our seeing it" (1993, p.53).

Circularity is thus in no way to be confused with vicious circles. Particularly in systemic **semantics**, this dictionary uses circularity in a positive way to induce a kind of intra-dialogue in the user's mind by criss-crossing through the whole **semantic field**.

In correspondence with **organizational closure**, circularity is also a characteristic of numerous natural **processes** and systems, specially biological and ecological ones, as a result of the complex interplay of multiple **interconnected feedbacks**.

0444

CLADISTIC ANALYSIS^{2) - 5)}

A **taxonomic** tool in natural sciences based on the **clustering** of characters in individuals.

Those individuals whose respective **clusters** of characters are most similar are considered as the most closely related in **space** as well as in **time**.

If the individuals conform a temporal sequence, progressively growing **differentiation** from the type considered as original indicates the relative individual positions in the time sequence.

While cladistic analysis is basically applied in vegetal and animal **taxonomy**, it could be used in widely different disciplines, as for example the **evolution** of tools or that of related **languages**.

0445

CLANTHINK^{1) - 4)}

"An incorrect view held by all or almost all members of the **group** about something other than the complex issue being considered" (J. WARFIELD, 1994b, p.490).

Clanthink views are considered "obvious" by those who hold them. They frequently remain implicit and are never submitted to critical evaluation. This is one basic cause of so-called "**underconceptualization**" and **blindspots**, leading ultimately to unsound **decisions** and possible disasters.

Clanthink is particularly dangerous in international politics

WARFIELD comments: "Clanthink peaks when authority rather than exploration of logic drives activity. It is generally easily exposed when, in the questioning **processes** used, inconsistencies begin to appear in dialog, causing the **group** to make discoveries that are counter to what previously believed" (1995a, p.65,6).

In many cases, **action** based on clanthink is officially supported by the **group**, but can be covertly sabotaged by unconvinced hidden opponents. It also may face strong opposition from **stakeholders** who were not consulted (in some cases because they were suspected of not sharing the clan's views).

0446

CLASS¹⁾

"A collection of things having some common property".

T.A. and W. MILLINGTON state: "All classes of measurements, **objects**, persons, etc., must be defined between precise **limits** so that no one member of the class may, inadvertently, be put into more than one class" (1966, p.43).

However, in some cases, the practical impossibility to obtain such precise definition led L.A. ZADEH to the **concept of fuzzy set**.

0447

CLASSIFICATION³⁾

The ordering of a number of **elements**, **relations** or **systems** according to some pre-defined characteristics.

Classification is basic for the organization of **information** into frameworks and the typification of systems. It is however a difficult subject.

M. MARUYAMA clarifies some important points:

"... the classificational universe is characterized by its being divided into **categories** and subcategories... The **structure** of this universe is **hierarchical**. The **relations** are conceived in terms of the kinship in the **hierarchy** of superdivisions and subdivisions" (1966, p.55).

Classifications tend thus to be ordered in **hierarchical "trees"**, which supposes **criteria**... not necessarily accepted by all concerned people, because they are selected "ad-hoc" by the classifier.

Moreover R. SOKAL showed that different ways of **clustering** the **elements**, when all are endowed with characteristics of various types, lead easily to the possibility of alternative classifications (1974).

Another significant aspect observed by MARUYAMA is that: "The **relations** are static" (Ibid.).

Classifications are more **structure-oriented** than **process-oriented**.

However, "Classifications may be **polycriterial**, i. e., several classifications using mutually independent **criteria** may be surimposed" (Ibid., p.56), as for example, listing people by age and, otherwise, by alphabetic order of names, or birth place. Each specific **criterion** produces a selected **set**, but the different **sets** present intersections, which can be tabulated

or otherwise studied. For such purposes, multi-dimensional **matrixes** or **fractalized VENN diagrams** can be constructed (A. EDWARDS, 1989).

0448

CLASSIFIER²⁾

"A set of condition/action **rules**" (J. HOLLAND, 1992, p. 172)

Classifiers are necessary in **adaptive systems**. They work on **inputs**, detected from the **environment** by specific **sensors**. Any such input is matched with the behavioral **set of rules** proper of the system, according to a general "if... then" **rule**.

In HOLLAND's **model**, an **output** is produced and fed back to the **environment**. The obtained result may lead to an **adjustment** of the rules strength.

This is similar to the **back propagation algorithm** (HINTON, 1991).

Classifiers are basic, for ex. for **pattern recognition**.

0449

CLIMAX⁵⁾

The final **state** towards which an **ecosystem** tends asymptotically if no significant **disturbances** occur.

Of course, as any **ecosystem** exists in a specific **metasystem**, many significant **changes** may happen: a permanent **change** in temperature, or salinity, or humidity; or massive human interference with natural conditions, etc.

Perfect and definitive climaxes do not exist.

Climax could however be an approximate **cyclical model**. H. ODUM writes: "Systems which have some constant or repeating **patterns** with **time** are called climaxes by ecologists" (1971, p.79)

This notion is thus quite akin to **dynamic stability**, while suffering however from the same limitations.

0450

CLOSURE³⁾

The property of a system to maintain its own internal **order** and **identity** within defined and permanent **boundaries**.

The condition for closure is internal **recursivity** in the system, as demonstrated by H. MATURANA and F. VARELA.

F. HEYLIGHEN states: "Closure of a **substructure** within a larger **structure** means that the external **distinction** (between the substructure and its complement or **environment**) is enhanced, whereas the internal **distinctions** (between the **elements** or **components** of the **substructure**) are reduced. In other words, closure diminishes the **coherence** between the **substructure** and its **environment** while amplifying the internal **coherence** of the **substructure**". (1990b, p.488)

The word "**substructure**" (used by HEYLIGHEN in a paper about **representations** in quantum mechanics) could be usefully substituted by the word "system", since the concept of closure is very general.

Structural closure, in particular, implies the construction, reconstruction and repair of the **parts** of the system. As to **cognitive processes**, closure leads to their **circularity** (H.von FOERSTER – 1992, p.68)

Closure, in its organizational sense, "a logical attribute" in E. SCHWARZ words, "should not be confused with energetic closeness (or **openness**), a physical **level** attribute" (1993, p.3)

→ **Organization: a descriptive language**

0451

CLOSURE (Statistical)²⁾

"The necessity for the collective statistical **constraint** to close back on the internal, detailed **dynamics** of the **elements** of the collection".

This principle has been introduced by H. PATTEE, who explains: "... **hierarchical controls** arise from a collection of **elements**, but act on individuals of the collection. The spontaneous appearance of collective **constraints** must therefore be a statistical property of the collection, but its **control behavior** must act on the **dynamics** of individual **elements**" (1973, p.95-6).

Collective **constraints** are the factors that institute social **coherence**, precisely because they are at the same time reciprocal and global. **Ergodic phenomena** appear in this way.

This already shows in fish schools (D. RITZ, 1991) and in locusts flights, but becomes stronger in anthills or beehives and, in many new ways, in human societies.

0452

CLUB OF BUDAPEST¹⁾

E. LASZLO, in a paper in "Cybernetics and Human Knowing" (1997, p. 47-51) presents in the following terms the aims of this Club: "The Club of Budapest is dedicated to the proposition that promoting and facilitating the evolution of planetary consciousness is a vital aspect of our sustained well-being and individual as well as social development. It is an essential mission of our time".

He also writes: "The Club of Budapest is committed to promoting and facilitating a worldwide movement keynoted by the advance from thinking in terms of the existing limits to growth to the emerging chances of evolution" (Ibid)

A "Manifesto on the spirit of Planetary consciousness" was published with a number of signatories, among them the Dalai Lama and a number of prominent political leaders, two Nobel Peace Prizes and other spiritual and intellectual leaders.

Further information on the membership and activities of the Club is available from its Secretariat: Szentháromságter 6H -1014 Budapest-Fax 36-1-175-1885

0453

CLUB OF ROME⁴⁾

An international group of scholars and businessmen created in 1967 by the Italian businessman Aurelio PECCEI and whose aim is the study of human problems on a global scale.

The Club or Rome started by ordering to the Massachusetts Institute of Technology (M.I.T.) a study of the **trends** that may endanger our planetary society in the making.

This report, methodologically based on J. FORRESTER's **Systems dynamics**, was published in 1972. It stressed the **interactions** between five global critical factors: demographic explosion, food production; industrialization; exhaustion of natural **resources** and global contamination.

The quite pessimistic conclusions of the report triggered a flood of criticism, based partly on doubts about the soundness of the **methodology** and partly on ideological bents and biases. More reports were then ordered by the Club of Rome, using the same **method** for different **purposes**. The true aim of PECCEI and his friends was however not to make precise and irrefutable **forecasts**, but to draw worldly the attention on possible evolutive contradictions within our **mega-system** forming.

It is now recognized that we are all "Groping in the dark" (D. MEADOWS et al., 1982), after two decades of global **modeling**, because the tangle of interacting systems is so complex that it is hopeless to ever reach secure conclusions. Moreover, during the seventies, when the **models** were constructed, neither the implications of **deterministic chaos** were taken in account, nor the stochastic aspects of **dissipative structuration** in our obviously **far from equilibrium systems**. But at least we know it now and become more and more aware of the need to monitor **long term global trends**.

0454

CLUE¹⁾²⁾

Any **observation** or **information** that contributes to a better **understanding** of a **process** or **situation**.

Of course, a clue gains its value only for the **observer** who is able to give it a **meaning** within a wider **frame of references**.

Photographic plates stored in a closed drawer that became veiled side by side with a sample of a yet not well known mineral became the first clue of this new **phenomenon** at the end of the 19th C.

But the clue made sense only for Becquerel and the Curie's because they already knew about ionizing radiations. Quite numerous scientific discoveries resulted in the same way from a clever interpretation of some clue.

In a lighter vein, clues were always meaningful for the keen eyes and acute **perceptions** of Sherlock Holmes...but only for him!

→ **Causality; Effects (side); Predictive event; Serendipity**

0455

CLUMPERS and SPLITTERS¹⁾³⁾

This amusing expression about two quite different types of minds (New Scientist, Nr. 2211, November 6th, 1999) surely deserves being included in this work.

"Clumpers" would be the authors of grand unified philosophical or scientific theories. Newton or Darwin would be paradigmatic examples. As to "splitters", the enormous majority of researchers in any discipline, they would be the hardworking, more or less anonymous toilers, painstakingly collecting myriads of small **data** or reduced specific **models**, which would one day allow for some breathtaking synthesis by some "clumper"... as for example the treasure of specific **data** obtained by numerous chemists, which were finally ordered by Mendeleiev, the clumper, in his famous periodic chart.

Systemists tend to be clumpers, but it should be very risky for them to ignore the laborious works of the splitters. As to the splitters, their work gather more sense and **significance** within the **mental frame** of already existing wide embracing theories... even if their discoveries may well lead to some shattering conceptual revolution.

0456

CLUSTER^{1) - 2)}

A more or less interacting gathering of **elements** within a common **environment**.

Clustering is the result of existing **patterns** of circulation within the **environment**, which tend to create more or less **homogeneous** local conditions, as opposed to global **heterogeneous** ones.

Clustering can as well be more or less local, i.e. in **composite systems** many local proto-clusters may coexist, with only a very loose **interaction** (if any) until their concentration increases up to a **critical threshold**, where suddenly a global cluster appears through part or whole of the **region**. The increased closeness of the **elements** tends to trigger more **interactions** among them. This may lead to a higher **level of organization**, which in turn may become stabilized (**frozen cores**), or not.

Clusters can be observed among such diverse kinds of **elements** as stars and galaxies, plants and human settlements, political **organizations** and systems of ideas. Clustering is thus an important systemic **concept**.

0457

CLUSTER ANALYSIS²⁾

A method used in the study of **parallel processing networks** to establish in a global way what **information** the **nodes** are sensitive to in a **learning rule** (Adapted from W. BECHTEL & A. ABRAHAMSEN, 1991, p.304).

Such a method is more practical than trying to study the **sensitivity** of all **nodes** separately.

0458

CLUSTERING²⁾

The progressive ordering of **relationships** within a flow of **information**

(**Information** is given here its most extensive meaning).

Such a **process** is spontaneous in young animals, and in babies, still more so when reacting to more elaborated **stimuli** from grown ups.

Any **relationship** in itself contains the basic features of **meaning**. This is made very clear by STEINBUCH's **learning matrixes**, with the transit from a **learning phase** – which connects a specific **stimulus** or experience with a specific **signal** (being this also the basics for conditioning) – leading to a **knowing phase**, which in turn opens the way to use acquired **knowledge for action**.

Recent advances in **robotics** are now also oriented to "...make **machines** that acquire meaningful **representations** of the world with as little intervention as possible"(D. GRAHAM-ROWE, on P. COHEN's research – 2002, p. 22-23). We could be on our way to self-constructed **artificial intelligence**. (see also: **Artificial Life**)

As noted in very general terms by F. DRETSKE (1981), **meaning** comes from **interactions** with the **environment**. It derives thus primarily from a more or less high quality of **perceptions** – something that F. ROSENBLATT already had understood with his **perceptron** (1961 and 1962). Experiencing with the **environment** is also a core feature of **autopoiesis**. Clustering, finally, as a **process**, is closely related to the construction of **constraints** in ASHBY'S sense.

0459

CO-ADAPTATION

→ **Adaptation (Reciprocal); Red Queen Evolutive Parable**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0460

COALESCENCE¹⁾

A **process** of progressive concentration of formerly scattered **elements**, centered on a **nucleus**.

Coalescence results of **random** movements of scattered **elements** which casually produces some local concentration. Thereafter this core or "seed" starts to act as a center of **aggregation**

→ ("fractal aggregation", "nucleation mechanism")

It is a **percolation**, or an **emergence phenomenon**.

Coalescence is quite general and is verified in many cosmic, biological, economic and social **processes**.

0461

COALITION¹⁾⁴⁾

"Attractive **interaction** between a pair of **functions** increasing the **probability** that they follow each other in **space** or **time**" (R. FIVAZ, 1996, p.143)

The opposite phenomenon is **competition**.

0462

CODE^{1) - 2)}

A specific **set** of **signals** and their **rules** of **interconnection**, forming a **communication** system used to transmit **messages**.

There exists a great **variety** of codes.

Some have a material base, as for example the old flags code in the navy, or any printed **alphabet**. Others use modulations of some form of **energy**, as for example sound waves or electro-magnetic ones.

There are also more abstract types of codes, all of them somehow related with **transmission** of some kind of **information** between sentient and intelligent beings.

Written or spoken **languages**, with their specific phonemes, morphemes, vocabularies and syntaxes, are of this type, as well as logical and mathematical **languages** and some more specific scientific sub-**languages** used in specialized disciplines.

For any **transmission** of **information** at the mental **level**, both an abstract code and a physical one are generally needed in a sequential way.

The use of any code supposes that it is known by **receivers** as well as by senders.

Codes must be sufficiently permanent and rigid in order to remain useful.

0463

CODE (Analogic)²⁾

A code based on pictures, **graphs**, etc... with **magnitudes** related to some defined **scale**.

0464

CODE CONSTRUCTION
(In human conversation)⁴⁾

R. GLANVILLE observes that the notion of **coding** is mostly "seen as what spies do, what Alan TURING showed us how to handle and crack/decipher"(1997, p. 60). He observes: "These codings are codings of literal **connection** and **transformation** in which one sequence may be represented exactly by another, which may in principle be de-coded provided the encryption key is to hand. They are in effect, **tautological**".

So, this type of codes, once constructed, is invariable within the limits of its base-**algorithm**. However this is not so in the case of **human communication**. Once past the bare **rules** of the grammatical or syntactical use of a specific spoken **language**, human **conversation** goes to a second order codification which is progressively constructed between the conversants and is ever evolving. The general concept of interpersonal code construction was developed by Gordon PASK in his very last paper (1996, p. 350-361) wherein he derives the basic idea from H.von FOERSTER's **self-organization** concepts as the "Progenitor of Conversation and Interaction Theories"

GLANVILLE's essay stirs deeper into the subject. He concludes: "By involving the **observer** as conversationalist, by not relying on prior, agreed **meaning** (However could we agreed it?), by insisting that meaning is personal and is not communicated, by keeping the form of **communication** separate from the **content**, **conversation** provides a much more basic, much more general, much less demanding, much more cybernetic **understanding** of how **communication** can happen in the world of today"(Ibid, p. 64)

0465

CODE CREATION^{1) - 2)}

The extraction of significant **algorithms** from redundant **information**.

An **alphabet**, for example, is the most constrained collection of sounds used in a spoken **language**, or also graphic **representations** of these sounds in its written form. (or should be, since in french for example nasal sounds as "on", "an", "un", etc..., are not represented as a single letter in the **alphabet**).

This kind of **compression** is also obvious in the "**part-for-whole**" coding explained by G. BATESON: "The verbal **message** 'It is raining' is to be seen as a **part** of a larger **universe** within which that **message** creates **redundancy** or **predictability**" (1973, p.391).

This **universe** must of course have been learned before it can be used as a **frame** for code creation.

There are many types of codes: **digital**, **analogic**, **iconic**, **metaphoric**, etc...

0466

CODE (Digital)^{2) - 5)}

A code based on positions in a **matrix**, expressed in **bits**.

G. BATESON gives the following examples: "... the telephone exchange is a purely digital computer. It is not fed with **magnitudes**, but only with names of positions on a **matrix**". However, "... Cartesian **graphs** are **analogic**" (1973, p.343)

0467

CODE DUALITY²⁾

J. HOFFMEYER and C. EMMECHE introduced this notion (1991). Hoffmeyer writes: "Code duality refers to the fact that **living systems** always form a unity of two coded and interacting **messages**, the analogically coded message of the **organism** itself and its redescription in the **digital code** of DNA. As analog codes the **organisms** recognize and interact with each other in the ecological **space** giving rise to a horizontal **semiotic system** (the ecological **hierarchy** of Stanley SALTHER (1985), while as digital codes they are passively carried forward in **time** between generations (after eventual recombination through meiosis and fertilization in sexually reproducing species). This is of course responsible for nature's vertical **semiotic system**, the genealogical **hierarchy**"(1998, p. 34)

0468

CODES (Linguistic and Semantic)^{3) - 4)}

A consensual **set** of **meanings** among a number of emitters or senders and **receivers** which allow them to exchange **information** understandable by all of them.

No **information** can exist without a **language** which provides a **semantics** (apart from the physical **codings** already referred to). **Semantic coding** is also a **process** of **consensus**: a number of senders and **receivers** must reach a general agreement about the meaning of words (groups of sounds) and sentences (group of words).

For example, the users of this dictionary must necessarily share with us the basic linguistic **code**, English, before being able to study, admit, reject or accomodate for their own use the systemic **metalanguage** here proposed. To make this point perfectly informative, here is a sentence in a **language** that most readers probably do not know: "Mutoto alivunja sahani moya". The only **information** therein contained for someone who ignores kiswahili, is that the sentence, if not fanciful, must contain some hidden **information**.

Linguistic codes are generally shared by a definite human group, in **space** and **time**. Every **language** conveys **information** in a specific and peculiar way. This is why the Italians say: "Traduttore, traditore". It is really very difficult to find a non-scientific word whose

meaning is identical in various **languages**. Witness, for example, the quite different sense given to the word "democracy" in different nations. Moreover, **meanings** vary with time: they are not only culturally-subjective but also temporally-subjective.

All this is true even for most of the **scientific language**. While we have a unique rigorous and universally imposed **meaning** for units like the hartley, the ohm or the joule, we are quite less sure about **meanings** when we speak of "determinism", "autonomy", "randomness" or "information", for example.

0469

CODING²⁾

The physical and/or **semantic translation** of a **message** into a precisely defined **code**.

In fact, **communication** entails successively **encoding**, **transmission** in the **code's language** and **decoding**.

0470

CODING (Selective)²⁾

Mechanism or device through which only some specific **inputs** are recognized as compatible with the system and thus accepted.

According to D. KATZ and R.L. KAHN: "Through the coding **process** the *blooming, buzzing confusion* of the world is simplified into a few meaningful and simplified **categories** for a given system. The nature of the **functions** performed by the system determines its coding **mechanisms**, which in turn perpetuate this type of functioning" (1969, p.96).

The basic coding of any system is defined by the characteristics of its original constitution (See: **Archetype**)

Moreover, coding acts as a powerful **constraint**, limitative of the numerous possible **disturbances** brought by the **environmental variability**. However, there is a price to be paid, i.e. the impossibility for the system to perceive more than a small fraction of its **environment**.

Man solved partly this problem by creating **codes of coding**, as for example those which allow for the indirect **perception** (by their effects upon **readable codes**) of numerous radiations or microscopic **objects** or very distant astronomical **objects**.

0471

COGNITION^{1) - 3)}

The acquisition of an ordered and operative **understanding** of ourselves and our **environment**.

H. MATURANA thus states the **autopoietic** view on cognition: "... reality and its cognition had to (i.e. have to) be accepted as a mode of **operation** of the nervous system as a closed **neuronal network**" (1979, p.25).

He also writes: "**Living systems** are cognitive systems, and living as a **process** is a **process** of cognition" (1980, p.13).

As to "reality", this view may seem somewhat extreme. We should perhaps speak here of "perceived reality".

As to cognition, we seemingly cannot do without some explanation about the **autogenesis** of such "closed **neural networks**".

Also von FOERSTER presented "... evidence that cognition is a continuously recursive computation of **descriptions** of reality" (K. WILSON, 1979, p.32).

This amounts to an **analogy** of the **brain** as a biological **computer**. This **analogy** however should be taken with much care, because the **brain**, in any case, is obviously not a simple **sequential computer** and apparently **constructs**, in some not yet very well understood way, its own **recursive algorithms**.

0472

COGNITIVE BLINDSPOT³⁾

Our incapacity to perceive this that we do not perceive.

This notion, introduced by von FOERSTER, using the **metaphor** of the ocular blindspot has also been formulated by:

- the French economist J. FOURASTIÉ, who spoke of the "ignorance of ignorance".
- by G.de ZEEUW, who uses the term "**invisibility**".

Cognitive blindspots are very dangerous, because they leave us in the false security that what we know covers the whole of what can be known. This does not allow us to see the narrow limitations of our **knowledge**.

→ **Blindspot**

0473

COGNITIVE COMPRESSION³⁾

The reduction of the **complexity** of conceptual **structures** through **categorization**.

This **concept** has been introduced by P. CHURCHLAND.

Cognitive compression is operated, or at least expressed through **language** which, according to A. and H. DAMASIO "... helps to **categorize** the world and to reduce the **complexity** of conceptual **structures** to a manageable scale" (1992, p.63).

Thus a **process** of **abstraction** (also described by the **structural differential** of A. KORZYBSKI) becomes practically operative as "the cognitive economies of **language** - its facility for pulling together many **concepts** under one **symbol** - make it possible for people to establish even more complex **concepts** and use them to think at **levels** that would otherwise be impossible" (Ibid).

The authors give two examples, widely different.

The first one is the general **concept** of "screw-driver", which does not create real difficulties. The second one, however, "democracy", implies some serious problems, as would any *abstract* "**label**" (to use KORZYBSKI's term), because the content of such compressed **categories** may be - and frequently is - dubious, as open to cultural or ideological manipulation (propaganda, brain washing, etc...).

0474

COGNITIVE DISSONANCE³⁾

M. TODA uses this L. FESTINGER's **concept** (1957) as follows: "... one may get an **information** which is so out of **range** of his expectation that the **validity** of his **cognitive simulator** may be seriously doubted... On the other hand, the **structure** of the **environment**, particularly that of a society, may not remain the same in the long run, and the **validity** of the frozen **cognitive simulator** will be degraded accordingly" (1976, p.83).

"frozen" is a very significative adjective in this case: it transmits with full clarity a critical aspect of mental **algorithms**, which need to be stabilized in order to become useful, but may altogether become counter-**adaptive**.

TODA makes the point: "So once one starts to "defend" his **cognitive simulator**, the need for defence will increase in frequency following the **validity** degradation, which will in turn decrease the real **information input**, and this may very well be the beginning of a vicious circle" (Ibid).

0475

COGNITIVE MAP^{1) - 3) - 4)}

"The mental **image** or **representation** made by human individuals and **groups** of their **environment** and their relationship to it" (LASZLO, 1993, p.315).

J.J. GIBSON, on the basis of the physio-psychology of visual **perception**, criticized this **concept** of a map "... supposed to exist in the mind" (1986, p.199). In his view, the **understanding** of the **environment** is a progressing **process**. This does not seem necessarily contradistinctive to the **map model**. While our **perception** is indeed sequential, revealing **meaning** as we go, this **meaning** was generally learnt and stored, i.e. **mapped** from previous experiences. We do not know what we are going to find out, but we are prepared to understand the **meaning** of the clues, as we are going on.

According to A. LASZLO, a cognitive map: "... involves not only the rational aspects of attitudes and **behaviors**, but also the **value** and belief **components** that shape human **perception**. As such, human cognitive maps signify the particular **representations** or **images** of social and physical reality formed in the **brain**" (Ibid).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

He adds: "This map allows us to be consistent in our thoughts and **actions**. Factors of heredity (the fixed internal **environment**), **behavior** (characteristics unique to the individual), and social and physical **environments** (**variables** external to the individual) co-produce a general conception of the nature of the world and a particular **configuration** of **value**-principles that is more or less unique for each of us" (p.316).

And: "The individual cognitive map is shown to be the result of the effect of the **environment** on the **behavior** and the heredity of the individual, of **behavior** on **changes** in the **environment** and heredity, and of heredity on modifications in **behavior** and the character of the **environment**" (p.316).

Moreover: "To prioritize and preserve this **information**, cognitive maps must involve '**values**'. **Values** are **symbols** that serve to record **phenomena** and that catalyze reactions to them. On an individual **level**, cognitive maps are conditioned by the **values** and beliefs that are dominant in society at the time. By internalizing **values** derived from cultural **contexts**, individual maps incorporate a certain amount of developmental leeway" (p.318).

In other words, the establishment of cognitive maps depends on **values** as **templates** leading to the construction of more or less stabilized **algorithms** for the **organization** of **autopoietic behavior**.

0476

COGNITIVE MAPS (Societal)^{1) - 4)}

When an important number of individuals share quite similar cognitive maps, such a **consensus** leads to the shaping of kinds of societal cognitive maps that, in A LASZLO's words "... serve as vehicles for societies to probe **environments** quickly and effectively", giving them "the means ... to keep pace with accelerating **rates of change**".

However, when these societal maps are not anymore "in sync" with socio-cultural **dynamics**... they tend to perpetuate singular **responses** that no longer fit with the realities of a changed and changing **environment**" (1993, p.318).

Such **situations** lead to revolutionary upheavels and/or to individual psycho-pathologies, which can readily be observed in our present world reality.

0477

COGNITIVE MODEL³⁾

A cognitive model is in fact an intricate **array** of interconnected functional characteristics of the human **brain** directed at the understanding of so-called "**reality**". The model would depend on specific modes of **perception**; ways to construct internal **frames of references**; **memory** (a set of devices to store such frames in a more

or less permanent way);; probably inner imaging and **languages** to communicate with other **observers**.

The comparative value of different cognitive models is a controversial matter under at least three aspects:

- Different **cultures** understand cognition in different ways. Acupuncture and ayurvedic medicine are examples as compared to western medicine
- **Religion** based models of cognition cannot be equated to rational and scientific models. There are no unquestionable comparative **evaluations** of bouddhist psychology, hindouist yoga, coranic or christian teachings
- Even scientific cognitive models have evolved deeply in the western world for example from rational and **linear causality** and Cartesian **method** to let us say-cybernetic **nonlinearity**, so called **holism**, auto-poietic **closure**, Popperian refutation and/or Heisenberg's **indeterminacy** (among others)

→ **Three R's of hard sciences**

0478

COGNITIVE OVERLOAD^{1) - 3)}

A **level of information** that cannot be registered or assimilated because it exceeds the **receiver's** capacity.

J. WARFIELD stresses that "The rate of presentation of **information** for **processing** by the human mind must be controlled, to avoid cognitive overload" (Pers. comm.)

There is a **short-term limit** to idea-**processing** capacity, and probably a **long-term limit** to **assimilation** capacity, i.e. to the insertion of new **concepts** and **models** within global ordering **schema** and **frames** in the mind. This increases the risk of losing any **capacity** to understand complex **situations**.

When such **limits** are crossed, part of the **information** becomes lost and, in extreme cases, general confusion may ensue. The problem is becoming more acute due to the present **information** glut in our technocratic culture.

Cognitive overload seems now a definite risk not only for individuals, but altogether for **organizations** and **sociosystems**.

0479

COGNITIVE PANORAMA¹⁾²⁾

A conceptual superstructure that defines and identifies topics as logical places, displays relations and **connections** within these topics or **issues**

This concept has been introduced by H. BENKING. The following comments are Benking's explanations, plucked from a series of papers and lectures (see bibliography)

"The cognitive panorama is a metaparadigm to counteract cyberculture's anticipated impact due to its: 1) open-ended universality, 2) loss of **meaning** 3) loss of **context**"

It is now obvious that we risk drowning in an ocean of incoherent **data** which could lead us to total conceptual **anarchy**.

According to Benking, the proposed cognitive panorama "allows us to embody and map concepts in their context and develop common **frames of reference**"

Such a conceptual superstructure "helps us to locate and become aware of: 1) what we know or miss, 2) where we are and what we think, 3) where we miss, underuse or manipulate **information**. By avoiding a "flat" chaotic mess of data which leads to the known "lost-in space" syndrome, we actually define **cognitive spaces**.

Through reflection on conceptual positions, outlining and embodying situations or topics (logical places or containers) we can follow meaning into embodied context and **semantic spaces**, and also scrutinize abstract "realities" by exploring participatory and collaborative approaches.

→ **Conceptual navigation; Convertibility of meanings; Ecocube; Harmonization; Knowledge map; Underconceptualization**

0480

COGNITIVE PROCESS^{1) - 3)}

H.von FOERSTER writes: "No theory of cognitive processes can be constructed merely from sensorial **data**"... which he thus explains: "The excitations of a nervous **cell** code only the intensity, but not the nature of the excitation. **Codification** is only 'such and so much' in this place of my body, and not 'what'". (1992, p.58).

If so, we are left with a need to bridge the chasm between perceived nervous impulses and their **meanings**. This is the riddle that **constructivism** is trying to solve, through interconnected **concepts** like **circularity**, **operators**, **closure** and **algorithm construction**.

The cognitive process is now also explored through **artificial intelligence** research. A number of interesting papers By R.L. BROOKS, P. MAES and others, from a symposium on "Integrated Cognitive Architectures", were published in SIGART, Vol. 2, Nr 4, 1991.

Among the important aspects of the cognitive process, these studies emphasize: perceiving, interconnecting **perceptions**, acting, registering the positive or negative results of **action**, keeping these results registered for **further reference** (i.e. becoming able to use them selectively in future **action**), improving **behavior** (i.e. obtaining better results from **action**, based on cumulative experience).

This kind of progressive build up of cognition, integrated from **perception**, **action** and **memory** could be the bridge between old behaviorism, **constructivism** and **autopoiesis**.

K. KRIPPENDORFF describes the cognitive system as follows: "A **construct**, **map** or maze involving a collection of interconnected items of **knowledge** or beliefs held by an individual about himself, or about his physical or social **environment**, including the cognitive system of others" (1986, p.12).

The cognitive system must however be **self-constructed**, within the **limits** of inherited biological (and possibly cultural) **closure** by progressive **constraints** which channel and limit original potential **variety**.

0486

COHERENCE¹⁾

The stability of **functional** and **structural relations** between **components** or **subsystems**.

Z.W. WOLKOWSKI recently presented a synthesis of the uses of the coherence concept in numerous disciplines from physics to biology and social sciences, giving very numerous examples (only French ones, however).

He states that: "It deals with **space-time** relationship, **resonance**, **synchronization**, interference, harmony, **compatibility** and **integration**" (1992, p.63).

The concept of coherence may be considered as a strong systemic **isomorphism**.

0487

COHERENCE CONDITION^{1) - 2)}

The necessity for any **network** to maintain more or less stable permanent partial and local **circuits** in order to remain able to perform.

This **concept** has been developed by brain neurologists (W. SINGER, C. GRAY), but seems basic for the satisfactory working of any **network**.

D. HEBB's rule and St. KAUFFMAN's "frozen cores" help to explain how the **brain** can maintain itself as a going concern, being sufficiently (but not excessively) "**joined**", in ASH-BY'S terminology.

Coherence, in this precise sense, is however clearly an unavoidable necessity for any performing **network**, as for example **sociosystems** or **distributed multi-agents systems**.

0488

COHERENT ORGANIZATION

→ **Organization (coherent)**

0489

COHESION^{2) - 4)}

The result of selective interactions between the **elements** or **subsystems** of a system.

"Cohesion is a **gestalt** property of a system" (M. BUNGE, 1988, p.7).

In effect any system is governed by a global dynamic law (J. THIERIE, 1990, p.442).

M. BUNGE comments: "Interestingly enough, cohesion turns out not to be proportional to overall participation. Instead, it is maximal for middling participation – which is reasonable, since nil participation is incompatible with communality, whereas the participation of everyone in everyone else's affairs results in **anarchy**.

"Cohesion...emerges and submerges from **interactions** among the members of the group. It is a good illustration of the claim that **systemism** is a sort of synthesis of **holism** and individualism" (1988, p.7).

This explains altogether why **complex systems** are **semi-decomposable** (H. SIMON, 1958). Cohesion is centered around a **set**, more or less specific and localized, of basic **interactions**, eventually at different **hierarchic levels**.

→ **Hora and Tempus parable**

0490

COHESIVENESS^{2/4)}

The degree of **cohesion** in a **group** of **elements** or individuals.

In human groups, cohesiveness depends mainly of the communication **competence** of their members. The development of increasingly numerous and complex societies is obviously parallel to the development of spoken and other **communication languages**.

0491

COHORT^{2/4)}

A set of individuals as members of a **population**, sharing some peculiar characteristics.

It could be, for example, individuals born the same year, or those who make up a migrating **swarm**.

The numerical reduction of cohorts tends to impair the **stability** and, in some cases, the **survival** of a population, or of some specific characteristic of the same.

The notion is significant in **ecology**, in genetics and in **sociology**.

0492

COLLAPSE¹⁾

"A **catastrophic** change in a system which becomes, initially at least, overexcited such that some of the **parts** overstep the **constraints** of systems **rules**" (T.F.H. ALLEN & T.B. STARR, 1982, p.263).

"Overstep" is more likely to be **overshoot**.

ALLEN and STARR consider collapse as "characteristic of an overconnected system... which has so many **connections** between its **parts** that it is **unstable** and is wont to undergo uncontrolled **change**" (p.263-274).

This can be understood as the result of an excessive narrowing of the system's **stability limits** and **thresholds**, which enhances the probabilities of **overshoot**.

0493

COLLECTIONS²⁾

The status of collections of objects as related to systemic concepts is somewhat ambiguous (R. PATON, 2000, p. 147-159)

There are different types of collections, reflected in collective terms.

A heap of sand has merely vague systemic undertones, and this only since it has become used in relation with **chaotic dynamics**, **unstable equilibrium** and **power laws**. In these cases the systemic **behavior** of the collection is generally implicit and manifests itself through fleeting episodes.

A **swarm** of locusts or a **school** of fishes, or a **colony** of ants already show more constant common behavior, corresponding to variable degrees of **organization** emerging of reciprocal **constraints**.

A similar type or more or less coherent systemic organization appears in collections of humans when not very permanent: conferences or congresses for example.

Biology offers us examples of collections which have an organizing power within **complex systems**: the **genome** seems a clear case.

In short, collections seem to be a kind of pre-requisite **situation** or **state**, while their systemic value depends on the nature- and in cases, the **evolution** (see for ex. **Dictyostelium discoideum**) of the **relationships** among the **elements**.

→ **Stigmergy; Zero system**

0494

COLLECTIVE BEHAVIOR⁴⁾

A similar and simultaneous behavior in a numerous **group** of individuals of a same species.

Collective behavior can be observed in all societies, from amoebas to human groups. Coordination of moves or other activities results from some specific factor as for example **pheromones**, or reciprocal visual **perception** (in fish **shoals**, for example), or gestual or spoken **language**.

Normally collective behavior is reinforced by repetitive **action** that works as a positive **feedback**. This can even lead to exponential or massive **effects** (swarming, communal building, in insects...and people, panics, etc)

Curiously, in some cases some unfavorable factor, a **negative feedback** can lead to the reduction, or even the suppression of some **behavior**. C. Defrain and J.K. Deneubourg give the example of ants trails abandoned when a source of food is nearly exhausted or if some obstacle or danger intervenes. (2000, p. 147)

0495

COLLECTIVE BEINGS¹⁾⁴⁾

"Collective Beings are intended to be multi-systems having **components** contemporarily belonging to more than a single system, making emergent different systems even simultaneously. The **concept** particularly applies to interacting autonomous **agents** dynamically using same **cognitive models**" (G. MINATI, 2001)

Minati connects this concept with normative **ethics**.

→ **Human systems (rule-bound); Metalevel; Network**

0496

COLLECTIVE OBSERVER

→ **Observer (Collective)**

0497

COLONY^{1) - 4)}

A group of **elements** or individuals of the same type, which coexist in a correlated way, but are still able to maintain their own **autonomy**, or, at least, to recuperate it.

A colony is not an **integrated system**, nor even a **semi-integrated one** on its way to **organizational closure**. **Elements** or **subsystems** retain their **autonomy** and their **autopoiesis** at their own **level** (F. ROBB, 1989, p.61).

In a colony, even eventual specialization of the **elements** does not imply **irreversibility**, nor definitive subservience to the **whole**. For example, some colonies of poplar trees may become very extended and quite old. But even then, the individual trees, while all offsprings of the same original one, do not become functionally differentiated.

The case is somewhat different with colonial animals, like sponges where structural **differentiation** do exist, but can be reversed.

At the extreme limit of colonial existence, the social **phase** of the amoeba *Dictyostelium discoideum*, is irreversible and, after sporulation of some of the individuals at the top of the **structure**, all the others die and, when favourable conditions reappear, there is a reversal to individual existence, starting from the dormant spores.

It remains arguable if, somehow, a colony-stage may or may not open the road towards an **autopoietic system**. In effect, there seems to exist a progressive **transformation** in the **organizational dynamics** of social insects. In D.M. GORDON's words: "It seems that **task allocation** is channeled into more consistent **patterns** in the older colonies". More mature ants colonies also seem to learn how to prevent reciprocal encroachment on their foraging **range**. (1995, p.53).

According to some eco-ethological cases studies "...the **costs** and benefits of coloniality vary markedly with such factors as group **size**, the **frequency** of predation, exposure to parasites, etc...". P. Corning gives numerous examples in one of his papers on **synergisms** (1998b, p.21).

These intriguing features could be of very high interest for the study of the present **process of organization, conflict** avoidance and globalization of the human species.

For interesting observations about colonies, see J.T. BONNER (1955, 1988).

0498

COMBINATORIAL ANALYSIS^{2) - 5)}

The mathematical study of all types of combinations and permutations, and their properties.

The subject is closely related to factorials, **graphs theory, groups theory, lattices and matrixes**.

K. KRIPPENDORFF refers himself to "Combinatorial explosion" which "occurs when a small increase of the number of **elements** that can be combined increases the number of combinations to be computed so fast that it quickly reaches computational limits (**BREMERMAN's limit**)" (1986, p.12).

0499

COMBINATORICS⁵⁾

"That branch of mathematics concerned with the **variety** of combinations of **elements** that are possible within given **constraints**" (KRIPPENDORFF, 1986, p.12).

This includes "the number of **selections**, permutations, arrangements, **patterns** and **organizations** a system is capable of. Combinatorics is central to statistics and **information theory**" (Ibid).

The existence of **constraints** defines the **algorithmic** characteristics of the combinatorics.

Not all the theoretically possible combinations are practically possible.

→ **Factoriality; Zerosystem**

0500

COMMAND¹⁾

An imperative **message** whose aim is to modify the **behavior** of the **receiver**.

V. TURCHIN writes: "The **meaning** of a command is the way it changes the **state** of the **receiver**. In the classical limiting case a command leaves the **receiver no choice** at all, so that the **action** of the **receiver** is uniquely determined by the command. Computer **languages** can serve as an illustration" (1993, p.14).

The concept of command should be stripped from its originally limited psycho-social **meaning**.

On the other hand, TURCHIN also observes that in many practical cases, "the command leaves *almost no choice*" to the **receiver** (Ibid).

The sender of the command can never be sure that – due to the **time lag** in its **transmission**, as for example in a tele-piloted rocket – its general conditions of **validity** will remain changeless (or even that they were correctly evaluated).

0501

COMMENSALISM^{1) - 5)}

A relationship between two or more **organisms** which benefits one, or both, or all without harm for any of them.

Commensalism is thus a non-**parasitic** relation.

This concept comes from botanics and zoology.

Commensalism is an interactive ecological **phenomenon**. Its scope is more limited than **symbiosis** or **parasitism**. However, as such, it could be considered as a first step toward a closer individual or collective **relationship**, leading eventually to more complex **social systems**.

0502

COMMON SENSE¹⁾⁴⁾

The global intuitive way of **understanding** that results from the progressive **integration** through **learning** or **training**.

Common sense allows for quick understanding of, and **response** to many **situations** and **behavioral experiences**. It may sometimes "save the day" in critical circumstances that do not allow for long research or reflections.

The acquisition of common sense - which amounts to implicit immediately available **knowledge** for practical **action** - starts at birth and never concludes.

Common sense is however at least partly accorded to the particular **culture** in which any individual find himself inserted.

And, unfortunately, common non-sense also exists and may spread quite widely

0503

COMMONS^{1) - 4)}

Those **resources** considered of common anonymous ownership.

This very old notion was reintroduced and generalized by G. HARDIN in a famous paper (1968, p.1243).

In E. LASZLO words: "When the size and **resources** of the commons are limited, individual **competition** intensifies and, for a **time**, permits the enterprising actors to draw further profits. But eventually they exhaust the commons and bring about their own downfall" (1978, p.86)... and probably everyone's downfall.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

As stated by W.W. HARMAN: "Microdecisions regarding utilization of **resources**... which are reasonable from the viewpoints of corporate **management** and stockholders, developers and local governments, result in macrodecisions of **resource** depletion, **environmental** degradation, urban **crowding**, which are unsatisfactory to society at large" (1972, p.87). This was considered a key issue by HARMAN in 1972: It still is and practically nothing is done to confront this challenge.

We have nowadays multiple examples of this problem at every **level** of human **groups** and it becomes now also a planetary one: The global **interrelation** between the **ecosphere** and the **sociosphere** could very well cross a **threshold** of total **instability**.

The commons, in **process** of exhaustion as **sources**, are also in **process** of saturation as **sinks**.

0504

COMMUNICATION ^{1) - 2)}

The task of producing at one point of **space**, a **message** that was created at another point.

"The **interaction** between systems or **parts** of a system using a pre-arranged **code**" (J.Z. YOUNG 1978, p.290).

This definition emphasizes the preliminary necessity of a shared **code**, which seems obvious.

Which is however not always so obvious is that this **code** is generally quite complex, offering physical, perceptive, **semantic** and cultural aspects, in accordance, moreover with the characteristics of the **environment** shared by the communicating systems.

J.van GIGCH makes the point: "When Communications Sciences were dominated by SHANNON's work in Communication Theory... the human communication **channel** provided this scientific discipline with its **metaphor**: a system grounded in telephone and electronic technologies. However, this school of thought has been superseded and displaced by a more comprehensive view which embraces not only the **syntactic**, but also the **semantic** and pragmatic views of communication. Therefore, this field can be associated with the **metaphor** of a relational exchange system designed to influence" (1993, p.50).

As observed by K. KRIPPENDORFF, the former view of communication as merely the **transmission** of **information** from a sender to a **receiver** (SHANNON) has now been extended to **interactions** within complex **networks** with numerous **feedbacks** among **elements** or participants.

Indeed, some kind of communication is the unavoidable condition for any **interactions**, starting at the very physical **level**, and for **sociality** in **ecosystems** and in **living systems**.

→ SHANNON limit

0505

COMMUNICATION and BEHAVIOR ^{1) - 4)}

D. Mac KAY states: "The object of communication is to select some particular conditional readiness in the recipient from the range of **states** that are possible" (1963, p.28).

A specific behavior may be thus elicited, but it may also remain potential, or be different, depending of complementary circumstances.

Mac KAY gives the following example: "... someone is telling you: 'it's raining'. What happens? You may be immersed in a book, and may not even feel inclined to grunt an acknowledgment. But this does not mean that your **understanding** of the **message** had no effect on you. If a sudden call comes for you to go outdoors, for example, you may be ready to reach for umbrella or mac" (1963, p.22).

Thus communication acts as either a potential or effective **trigger** of behavior. Ethological research shows this to be also the case with animals.

Communication is always in some sense an attempt by an **sender** to modify the **behavior** of one or various **receivers**. Communication is obviously a social **phenomenon**. In G.R. JOHNSON's words: "Communication is found wherever social life is found, from microorganisms to insects to humans. Some times these **processes** are dependent on visual clues... Sometimes they are based upon chemical clues... (or) anchored in auditory clues. And sometimes other clues are used – for example, tactile and electrical" (1992, p.1142).

0506

COMMUNICATION as CONTEXT depending ^{1) - 2)}

BATESON bluntly states: "... without **context**, there is no communication" (1973, p.378) and explains his view through an example: "A phoneme exists as such only in combination with other phonemes which make up a word. The word is the context of the phoneme. But the word only exists as such – only has '**meaning**' – in the larger context of the utterance, which again has **meaning** only in a **relationship**" (Ibid). He could have added: "...and in a specified **language**".

D. BOHM and F.D. PEAT express a very similar idea when they write: "In communication, **meaning** unfolds in the **structure** of the **language**, and **meaning** unfolds into the whole **community** and unfolds from the **community** into each person... "The explicate form of all this is the **structure** of society, and the implicate form is the **content** of the culture, which extends into the **consciousness** of each person" (1982, p.185).

This could indeed be considered a general ecological principle: nothing makes sense or has **survival** value without properly defined **connection** and communication with a *specific context*.

0507

COMMUNICATION (Cost of) ⁵⁾

W. S. McCULLOCH stated: "In a communication **code**, the price of a simple **Bit**, or answer to a yes or no question, remains constant, even when we halve the area of ignorance by every question, as we can in playing Twenty Questions. In making **measurements**, the price varies: the **range** of **uncertainty** diminishes inversely as the square root of the number of samples we average" (1974, p.11).

0508

COMMUNICATION (Failure in human) ⁴⁾

G. VICKERS describes three areas in human communication where failure is possible, namely in defining **problems**, in evaluating **programs**, and in securing **cooperation** and concurrence".

He states: "In more static societies the **relations** to be regulated and the **situations** which involve them are usually familiar and are often equally visible to all. In our society, the more numerous **relations** to be regulated combine in subtle and often novel ways and the **situations** which involve them have to be anticipated by techniques of **simulation**, often involving the **combination** of large volumes of **information**. So the task of defining the **problem** is by no means simple. *Ways of seeing the problem become obsolete, no less than ways of solving it...* This need constantly to restructure **problems** makes novel demands on communication".

As to the **evaluation** of **programs**: "The **situation** to which the policy maker attends is not a **datum** but a **construct**, a mental artifact, a collective work of art. It has to be simplified, or it becomes unmanageable: yet, if it is oversimplified, it will be no guide to **action**".

This comment makes clear the reason why our over-simplified or distorted media **messages** are generally so confusing for the public... and even possibly for their own senders.

As to secure **cooperation** and concurrence: "It has to reflect present and future reality; yet if it departs too sharply from the familiar thinking of the past, it will not be sufficiently shared by those for whom it has to provide a common basis for discussion. It has to be not merely discovered but invented, not merely invented but chosen from among several alternative inventions, each a valid but differently selected view. Most difficult of all, it must not obscure the views which it supersedes" (1967, p.63-65).

There is of course much ground for communication failure. This is why *co-participative design* seems necessary to obtain and maintain workable **consensus**.

0509

COMMUNICATION (Human) ⁴⁾

The organized interactive **behavior** among a human group.

Human communication supposes not only the physical transmission of coded **signals**, but moreover the existence of a shared cultural and **semantic code**.

The neglect of this basic condition has been one of the main bones of contention opposing psychologists and social scientists to systemists. In the words of L. THAYER in 1972: "Many spokesmen for **general systems theory** do not address themselves to the **phenomenon** of *human* communication at all. Among those who do, many seem to assume that there are no theoretically significant differences between an electronic **data** system and a human communication system. This terminological confusion, both real and potential, is perhaps even more pervasive among those who identify themselves as human communication scholars or researchers" (1972, p.95-6).

The roots of this problem are to be found basically in what is now frequently called the **1st. Cybernetics**, namely N. WIENER's works and SHANNON & WEAVER's "**Theory of Communication**" (many times erroneously referred to as a **theory of information**, which it is only in a marginal sense). In WIENER's case, **feedback** has been too many times understood as a **control** device of mechanistic character, translatable without much ado to psychology and psychosociology, as for example in B. SKINNER's works. SHANNON & WEAVER's *quantitative mathematical theory of communication*, considers **semantic** and **symbolic** aspects of **communication** only in the most fleeting way. Many of those who naively translated it to human communication obviously ignored G. PASK's, H.von FOERSTER's and D. Mac KAY's basic works, which led to **Cybernetics of the 2d Order**. Various other conceptual currents as for example **autopoiesis** and **organizational closure**, **hypercycles** and **deterministic chaos** are now contributing to put to rest the old purely mechanistic **paradigm** in psychosocial sciences. Unfortunately some scholars do not yet presently know about these new currents.

0510

COMMUNICATION (Layers of) ¹⁾

It is possible to distinguish various layers of communication, from the most basal physical one to the societal one. (In a sense, possibly somewhat metaphoric, any communication layer is societal).

Each layer institutes a higher **level of complexity**. For instance, physical communication leads to integrated atoms and molecules; chemical communication to biochemical complex molecules. Those in turn permit the shaping of complex **living systems** and their internal **coordination** (endocrinal, nervous and perceptive). Eventually nervous and perceptive **coordination** among individuals leads to social **integration**.

A layer of communication at a specific **hierarchical level of complexity** acquires **meaning** only through new specific **constraints**. (PATTEE's **statistical closure** – 1973, p.95-6).

0511

COMMUNICATION (Line of) ^{1) – 4)}

K. BOULDING stated that the lines of communication "... grow at a much slower **rate** than the total **organization**. Hence **organizations** eventually limit their **growth** by the sheer difficulty in getting communications from the "surface" of the **organization**, where it is contact with its **environment**, into the **decision-makers** who are not in direct contact with the **environment**, but have to make **decisions** on base of increasingly less realistic **images** of the world" (1972, p.70-71).

Organizations, and also other kinds of **social systems** react to this problem in two different ways, none of them totally satisfying:

- increasing **hierarchic centralization**, which reduces the general **adaptability** of the system.
- admitting more **decentralization**, which may produce in very large systems a tendency to fractioning and eventual **disintegration**.

The subject is also related, in more general terms, to the subject of **interrelations** between "Growth and Form" (d'ARCY W. THOMPSON – reed.1952).

0512

COMMUNICATION (Meta-) ⁴⁾

The non-conscious **transmission** and **reception** of a **message** embedded in a wider **significative context**.

Any non-rational communication is practically at least partly meta-communication: through religious faith, or art, for instance.

0513

COMMUNICATION (Physical) ⁵⁾

A physical **process** in which a material **transmitter** emits in a well defined **code** some **signals** which can be decoded by an adequate **receiver**.

Voices or sounds, musical or others are transformed into electro-magnetic waves and reconverted to sounds by a telephone or an audio-set.

Thereafter the sounds are received by our hearing system and converted from sound waves to sensations.

Similar **processes** allow for the **transmission** of visual **signals**, for example through a television chain.

These **processes** are completely independent of whatever **meaning** the **signals** may be intended to convey. Here, **coding** is a biunivocal physical **transformation** whose efficiency depends on avoiding perturbing **noises** or compensate them by adequate repetitions (= **redundancy**).

Any type of physical communication needs the following elements: an **emissor** or sender, an **encoder**, a **channel**, a **receiver** and a **decoder**, and... of course, a **source of energy**. Generally the communication **process** must also be monitored in order to ensure its correctness.

0514

COMMUNICATION PROCESS and MEANING ^{3) – 4)}

As stated by F. ROBB: "Communications are **interactions** involving the use of previously formed **meanings** to initiate **actions**, including further **conversations**" (1993, p.1). **Meanings** are socially formed through **conversation** and **consensus**.

ROBB explains how a human group or **organization** forms and stabilizes **meanings** by: "... the **aggregation** and "packaging" of bundles of **concepts** under pantechon **labels** and burying them along with all the other taken-for-granted assumptions in the **meaning set**. This having been done, these topics become forbidden for discussion and become part of the **reflex communication system**"...

A once for all bounded social and/or cultural communication **space** becomes thus defined.

"This shift from the discussion of issues to the embodiment of **concepts** in **automatic communication systems** is very familiar to managers" (p.2). They may however lead to **clanthink** (J. WARFIELD).

D. MacKAY writes: "Claude SHANNON'S measure of selective **information content** was framed explicitly to require no reference to the **meaning** of the **information** selected in **response** to a communication **signal**. The communication process was viewed as a transaction between terminals whose task was confined to the generation and **reproduction** of **symbols**.

"The **understanding** of these **symbols** was declared to be the concern of the communication engineers and the saying went abroad that **Information Theory** had no place for the concept of **meaning**" (1969, p.19)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Of course, the discrepancy is unavoidable when one speaks of "**symbols**" in this **context**, since "**symbols**" is understood either as computable logical signs or as something strictly from the realm of human **knowledge**. It would be better to use here the word "**input**", which is **semantically neutral**.

To make this point still clearer let us use an example. The atmosphere around us is presently densely crowded with a flow of radio and TV waves, beamed by appropriate material **transmitters** as **outputs**, but previously **coded** by men to be transmitted.

Most of these waves are lost, because no material **receiver** collects them. Those which are picked up, become **decoded** as sounds and images only as the **receiver** is switched on. However, still, if nobody stays in the room to listen and to view, sounds and images disperse without transmitting any **meaning**. Thus, we must include that the **meaning** is potential and becomes actualized only by the human **receiver**. Moreover, she or he must know the corresponding **semantic code** or **codes** without which the **message**, even correctly received, remains senseless.

Of course, SHANNON'S theory remains perfectly valid within its own limits, when referring to the **transmission of signals** and their measure as related to the *quantity of information* to be transmitted.

0515

COMMUNICATION SYSTEM (Physical) ⁵⁾

The core of any communication system is a **set** of material devices organized in order to function in a sequential way: A **transmitter**, or sender, a **channel** and a **receiver** (or a multiplicity of **receivers**).

Visible, auditive or electro-magnetic **signals** circulate within the **channel** from **transmitter** to **receiver**, differentiated through the use of some **code**.

The correct **transmission** of the **signals** can be disturbed by some **noise** emitted by an outside **source**, which invades the **channel**.

It should again be stressed that "the *technical* system of communication does not take into account the *meaning* of the **signals** either at the **encoding** (transmitting) or the **decoding** (receiving) end" (O.S. AKHMANOVA, 1960, p.183).

However, communication systems as a whole are used to transmit **messages**, emitted by some sentient or intelligent being after previous **codification** through a **language** that must also be understandable by the **receiver**. In any intelligent communication there is thus at least a double sequential **codification** and, at the **receiver's** end, **decodification**.

In a telephone conversation, for example, three **codes** are successively used: a **language**, the phonation and the electro-magnetic modulation.

0516

COMMUNICATION SYSTEMS (Human) ⁴⁾

L. THAYER states: "For the "**information**" engineer, a "**bit**" of **information** is a "**bit**", regardless of the time of day or the number of times it is used. Not so the **components** of human communication systems. An individual is not the same in one communication system as he is in another... There is always something which is significantly unique about an individual in every communication system in which he participates. The **components** of a human communication system are interdependent in that system in the sense that the only way they can be defined in *that* communication system is in relation to each other... In an "**information**" (read "**data**") system, the **data** are the **message**. In human communication, "**information**" is the product of a human transform of the **data**" (1972, p.111).

At this **meta-level**, every technical aspect of the **transmission of messages** remains basic, but the whole physical **process** is now the bearer of the psycho-socio- semantic **level's** products.

0517

COMMUNICATION THEORY ^{1) - 3) - 5)}

The theory of the **information transmission** under its various aspects.

The theory of communication has been established by C. SHANNON and W. WEAVER (1949). It is frequently referred to as "**theory of information**", which it is only marginally. In effect, what travels from a sender to a **receiver** is a **signal**, which may, or not, convey an understandable **meaning**, when conveniently, or not, coded in a **meaning bearing code**.

The theory states in a general way the conditions for the reliable and correct **transmission** of **data** (or **information** if these **data** are included in an interconnected global system). It includes the study of physical **codes**, **channels**, **transmitters** and also **noises**, that can distort or destroy what is transmitted, and of the conditions needed to make up for these negative **effects**, i.e. the use of **redundancy**. It also establishes ways to organize and quantify **information** for its **transmission**.

The fact that **information** is *organized* explains why **entropy** is proportional to the lack of **information**, as demonstrated by SHANNON. However, the use of the term "**negative entropy**" frequently associated with **information** has been seriously questioned.

Communication theory can, in principle, be applied to any **mode of transmission of information**, be it nervous, visual, by sound, electronic or, in a different sense, **linguistic**.

The basic **elements** of a communication system are: the **transmitter** (i.e. the **encoder** and broadcaster), the **code** itself with its basic units (for example **bits** or **bytes**), the **energy** impulses used, the **transmission** lines or media (**channels**), the **receiver** (i.e. the **decoder**).

In any case, as observed by H.von FOERSTER, Communication theory in its strict sense, is not much else than a simple general theory of communication technology.

0518

COMMUNICATIONAL MODES ⁴⁾

G. BATESON states that rational, logical and verbal communicational modes are merely some particular modes of human communication. Examples of others are: "... play, non-play, fantasy, sacrament, **metaphor**, etc." (1973, p.174) He observes even among the lower mammals "exchange of **signals** which identify certain meaningful **behaviors**" (ibid).

He could easily have added at least social insects and probably some non-vertebrate **colonial** animals like medusae, sponges, etc., if communicational modes are to be identified by the **effect** on some **receiver(s)** of **signals**, meaningful for them, emitted by some **sender(s)**.

Should one admit that communication does not necessarily imply psychism, it could be even be rooted at quite more elemental **levels**: genetic, chemical or physical.

0519

COMMUNICATOR ⁴⁾

Anyone who transmits **information** to other people.

A. LOTKA, taking up an idea also emitted by A. KORZYBSKI (1933, 1950), writes: "Man is the only animal who in any considerable measure bequeaths to his descendants the accumulated wisdom of past generations. **Evolution** in this case proceeds not merely by the slow **process of selection**, but is immensely hastened by the cumulative and continuous growth of a body of **knowledge** exempt from the law of mortality which sets a term on the life of the individual" (1956, p.379)

To a greater or lesser degree, we are all communicators and it is mainly this **function** which shapes society.

From the viewpoint of **evolution**, we could speak of a kind of collective lamarckian heredity of acquired mental characters.

The existence of communicators in non-human systems has not been researched to any great extent, save in ethology. However the presence, at the genetic **level**, for example, of **elements**, specific bearers of the communication **function** seems to be essential to explain

organizational closure and **autopoiesis** in **living systems**. The same question is also latent within the ecological hypothesis of the "**planet system**" ("**Gaia**")

0520

COMMUNITIES (Types of Human)⁴⁾

During its 1998 Conversations, the **Fuschl Group** strongly felt the need to establish clear distinctions between different types of human communities in **history**, in our present time and, possibly, in the future.

This need appeared in connection with the general aim to reach a better **understanding** of the ways toward the instauration of harmonized evolutive human communities, that could avoid through generally participative **design** the tragic political and social disasters of the past and the present.

After an extended debate the following typology of human societies was tentatively established. The typology is evolutive, as the Group understands that there is a progressive (but also at times catastrophically **discontinuous**) **transition** from one type to the next one.

Such an **evolution** seems to be irreversible, but this cannot be guaranteed.

Traditional Community: A **closed, stable system** where the individual's **identity** is determined by a collective **identity** rooted in transmitted myths, **values, norms, and rites**.

Examples are clans and tribes, agrarian villages, religious communities.

This has been the dominant type until it became deeply eroded by the technical and demographic **transformation** of the two last centuries.

Surrogate Community: A **closed, unstable system**, artificially created to attract and satisfy disenfranchised individuals yearning for community through imposed **norms and values**.

Examples are proselitist ideologized **groups**, fundamentalist religious **groups**, religious sects.

The word "artificially" should be qualified. Most communities of this type are founded by charismatic leaders who, somehow, sense the existence in people uprooted from their traditional community, of a deep need to "belong" and are able to respond to it in accordance to their own needs and psychological conditions.

Learning Community: An **open and dynamic system** in which reactive and **proactive** individuals collectively adapt to their **environment**.

Examples are administrative **organizations**, business firms, political parties, scientific research **groups**.

This type of **adaptation** is made of more or less **discontinuous** episodes (for example in business mergers), but are not deeply evolutive.

Evolutionary Learning Community: An **emergent open system** demonstrating **dynamic stability** by adapting with its **environment** and generating sustainable evolutionary pathways.

Until now, such communities are very rare, as they must initially rely on **consensual** collective **self-organization** by a number of individuals who understand how to self-organize (and re-organize) and how to do it as a way to transcendent permanent **transformation** in a necessary evolutive way. (M. BENEDEK & G. CHROUST (Eds), 1998)

→ **Syntony Quest**

0521

COMMUNITY¹⁾

1. A **structure** made of interconnected individuals living in similar **environmental** conditions.

The individual members need not necessarily be all quite identical even if they are all of the same general type. They may very well carry out different **roles** or **functions**.

K. BAUSCH defines community as "A **group** of two or more individuals with a shared identity and a common **purpose** committed to the joint creation of **meaning**" (Glossary- Personal communication)

This is true in ecological communities as well as in human ones. Moreover, **heterogeneous** communities are stabler than **homogeneous** ones, since they possess more **diversity (variety)**.

2. The sixth **emergent level** of **complexity** in J.G. MILLER's **taxonomy of living systems**.

Communities are made of interconnected **organizations** (5th level) and, in turn, combine into structured and organized **societies** (7th level).

0522

COMMUNITY (Epistemic)^{3) - 4)}

A **human communication system** which is extended in **space** and **time**.

This **concept**, proposed by B. HOLZNER (1968) and here adapted from L. THAYER (1972, p.112), is thus explained by this last author: "Those who have been similarly *informed*, who have similar **frames of references**, similar **epistemologies**, similar "reality-testing" procedures, and who thus mutually validate each other's ways of knowing, can be said to be members of the same epistemic community" (Ibid).

Validation is always referred to a prior system of **values, concepts** and **behaviors** accorded within the community through an explicit or implicit **process** of **consensus**, possibly shifting as time goes on.

The crossing by individuals or groups of the **boundaries** of an epistemic community and their intrusion in another one, is generally known as "**transculturation**" and generates in many cases very serious problems of poor communication and intolerance, which may produce violent **conflicts**.

0523

COMMUNITY (Learning)

→ **Communities (Types of human)**

0524

COMMUNITY (Evolutionary learning community)

→ **Communities (Types of human)**

0525

COMMUTATION²⁾

"The **relation** in which **addition** and/or **multiplication** is **symmetrical**. Non commutation is the **relation** in which **addition** and/or **multiplication** is **asymmetrical**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.33).

In the case when added or multiplied **elements** are not all of the same type and their appearance is serial, the **relation** between them is necessarily non-commutative. On the contrary, in the case of grains of sand accumulating on a dune, or locusts in flight, the **order** of incorporation of the **elements** is irrelevant.

0526

COMPARATOR²⁾

That **part** of a **regulator** that meets the difference between the desired (reference) **input** and the real one.

The **control** unit in the **regulator** needs to be informed of the value of this difference, generally called the "**error**". The **error** triggers a suited **message** of the **controller** to the **effector**.

0527

COMPARTMENTATION²⁾

"Partial **closure** from the **environment** which is necessary for multiorder **feedback** to develop between the **components** within (the system)" (G.H. FAIRLOUGH, 1988, p.408).

The notion has been introduced by M. EIGEN and P. SCHUSTER in "The **Hypercycle**" (1979), with biological examples.

"By analogy, we can view compartmentation as critical to the **evolution** of self-organizing adaptive social systems" (FAIRLOUGH, p.408).

Compartmentation is hypothesised to lead to the shaping of a **boundary** by way of the progressive self-organization of **cyclic** and **hypercyclic** **feedbacks**. The final result should be complete **organizational closure** and **autopoiesis** (see "The Hypercycle", p.86).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Compartmentation could start with the appearance of **dissymmetries** in some specific surroundings. See Hans KUHN on this topic (1976).

0528

COMPATIBILITY¹⁾ – 4

Indispensable non-contradiction in the **behavior** of **elements** and/or **subsystems** in a **complex system**.

Non-compatible **elements** are those whose **behavior** produces **outputs** which are destructive for other **elements**.

What may be contradictory in the **behavior** of the **elements**, is a result of the **rules** which command such **behavior**. Some of J. CONWAY's **games of life** are **models** of self-destructive or self-blocking systems, due to **interactions** of incompatible **rules**.

No **complex system** allows for a long time the presence of **elements** or **subsystems** not being in harmony with its basic nature, as defined in its **central control subsystem**, which imposes its **organizational closure**.

Non-compatible **elements** are quickly identified, isolated and rejected as for example in the immune reaction or in case of exclusion of the human group. Racial, religious or cultural intolerance are probably kinds of social immune reactions, which makes them very difficult to avoid.

A specially interesting subject for research in G.S.T. would be a general inquiry in the ways to overcome or reduce **rejection reactions** when nocive.

0529

COMPETENCE⁴⁾

"The *qualification* to implement an **activity**" (G.de ZEEUW, 1992, p.1076).

de ZEEUW adds the following, in a descriptive way: "...using the **activities** or **resources** of other actors when necessary but without making such **activities** impossible or dominating such **resources**, and to continue implementing it even given unexpected and unpredicted **variations** in such activities and **resources**, that is *skillfully*" (Ibid).

Competence is thus connected with **adaptability** and **efficiency** in **networks**, mainly through the ability to order and compatibilize **processes**.

According to de ZEEUW, the degree of competence depends also on the use of a better **observational language**.

N. CHOMSKY uses the concept in **linguistics** to express the potential ability of a **language** user to understand and form an immense number of sentences, which she/he has in many cases never heard or used before.

In synthesis, competence is a potential for **action**.

0530

COMPETENCE (Communicative)⁴⁾

In a **heterarchical organization**, the capacity of any **element** to share his/her (and its, if the concept can be somehow translated to natural or artificial non-human systems) **knowledge**, experience, **information**, etc... to any other **element** of the **organization**.

J.A. JOHANNESSEN describes the conditions for communicative competence, as resumed hereafter:

- Listeners must be attentive, without interrupting
- **Knowledge** is in the **dialogue** and not with the single individual
- Recognition must be reciprocal and the **dialogue** free of **domain dominance**
- Only the power of rationality is to be used
- Principles of **complementarity** and **self-organization** are the bases of **dialogue**
- **Dialogue** must be constantly validated
- Every explanation is personal and fragmentary
- **Knowledge** is obtained through a shared **communication process**
- The minimum unit in **communication** is the "triad": **action** - **reaction** - resultant
- Pathology of **communication** should be clearly understood: self-contradiction, inconsistencies, shifting of **types (categories)**, obscurities, etc...
- An explicit evaluation of the surrounding conditions of **communication** is needed
- Participants establish a **metarule** for their **communication**
- **Dialogue** is based on **synthesis**, with the **problem** definition phase emphasized
- Premises and suppositions must always be explicit
- It is not possible to impose **linear** thinking upon **nonlinear** reality (1991, p.49-50).

These guidelines have much in common with J. WARFIELD's **Generic Design**.

0531

COMPETITION²⁾ – 4)

A mutually limiting **interaction** between two or more systems or **subsystems**.

R.L. ACKOFF and F.E. EMERY, quoting KATZ and SHANK state: "... competition is **conflict according to rules** and hence is *constrained conflict*" (1972, p.199).

"Repulsive **interaction** between a pair of **functions** decreasing the **probability** that they follow each other in **space** or **time**" (R. FIVAZ, 1996, p. 143)

Competition is basically caused by the scarcity of some **resource** needed by the various intervening systems, as for example **energy**, **space**, raw materials and **information**.

Competition leads easily to open aggression and **conflict**, but may also induce a **negotiation process** which, in turn, may be conducive to the establishment of a **regulator** or **control** device accepted by the competing systems.

In case of such agreement or enforced mutual limitation, the **regulator** becomes a basic **element** of a higher level of **organization**. Competition for **resources** then becomes a regulated **zero-sum game** between the systems or **subsystems**.

The cost of **regulation** is generally quite inferior to the cost of unbridled competition.

0532

COMPETITIVE ASYMMETRY²⁾ – 4)

Competition is usually asymmetric, which means that one (or some) of the competing **elements** or systems has an initial advantage or acquires it, obtaining thus a larger share of the available **resources**.

The study of competitive asymmetry led to a quite more complex view of the **evolution** of **ecosystems**, relativizing the concept of **climax**. It could also probably be applied to the **evolution** of oligopolies and monopolies in economy, and in balances of power in politics.

0533

COMPETITIVE EXCLUSION PRINCIPLE²⁾ – 5)

"One of two **populations** of self-duplicating **organisms**, if permitted to expand with **Malthusian growth** without selective **control**, will drive the other out of the realm" (H. ODUM, 1983, p.53).

H. ODUM, who enounces the principle, writes: "The one with the slightly better reproductive **performance** is **self-amplifying** and the discrepancy between the two stocks increases. This is a well-established **phenomenon** in laboratory experimentation where other **controls** are removed... This tendency for **run-away** competitive exclusion of one part of a **network** is a fearsome ever present danger against which all surviving systems must be protected by organizing influences" (Ibid).

In other words, the more **complex** a **supersystem**, the more dynamically stable are the participant systems. Eliminating seemingly competing systems is thus dangerous, specially because the remaining system can very well run away toward self-destruction through a **positive feedback** which encounters no more resistance.

A similar competitive exclusion **mechanism** has been proposed by ethologists as expressed by J.N. LOCKE: "If a brain **mechanism** has limited **capacity**, it may be preempted by early stimulation and rendered insensitive to later stimulation of a different type" (1994, p.441).

This explains for instance the life predominance of the mother **language** and the subsequent difficulties in learning other **languages**.

A similar idea had already been enounced by P. COLINVAUX in 1973 (p.337): "Stable populations of two or more species cannot continuously occupy the same niche". And even earlier, in 1934, the russian biologist G.F. GAUSE had formulated it (becoming known as GAUSE's Principle). By experiences on two different species of *Paramecium* put in **competition**, GAUSE showed that one of the species always finally died out. (1934)

While in more recent experiences with *Drosophila* seemed to infirm the principle in some cases, it remains however of very general validity.

Within some well specified limits, it may also prove to be applicable more generally to social **situations**. for example e-mail could conceivably eliminate finally common postal written or typed mail. Such extensions of the principle should however be handled with care.

0534

COMPILER⁵⁾

"A computer **program** which reads a computer **program** in a higher **level language**, usually in the one a human programmer uses to state his **problem algorithmically**, and translates it into the machine **language** of a particular computer" (K. KRIPPENDORFF, 1986, p.13).

0535

COMPLEMENTARITY²⁾

A way of **organization** whose "governing **relation** is **symmetrical dependence**" (FEIBLEMAN, J.& FRIEND, J.W., 1969, p.36).

This **organization mode** is related to **models of integrated systems**, as **parts** can hardly survive their splitting off. Complementarity implies that **parts** of different identities fit usefully, or at least satisfactorily with each other.

Complementarity is typical of very complex and **heterogeneous** systems, in which numerous **functions** and **structures** can operate and maintain themselves only by **cooperation**.

Complementarity is quite obvious, for example in James G. MILLER's description of the **20 critical subsystems in living systems**.

As a **concept**, complementarity carries some semantic **ambiguity**. According to J.A. GOGUEN and F.J. VARELA: "Our usual way of thinking about pairs of descriptive notions is biased in the direction of regarding them as mutual negotiations of the general form not-A/A. It is the case, however, that many of the most important such pairs operate by mutual specifications, that is, are complementary. We mention in particular, **content/form**; **semantics/syntax**; **autonomy/control**; **net/tree**; **minimal-model/behavior**; **simultaneous/sequential** and **environment/system**" (1979, p.40).

Others complementarities are: being/ becoming; levogyre/dextrogyre (in molecules and crystals); **stability** and **change**. Moreover, complementarity is not merely **binary**: many different **processes** and/or **functions** enter into intricate **associations** in **complex systems**.

0536

COMPLEMENTARITY PRINCIPLE (BOHR)^{2) - 3) - 5)}

In the first years of 20th Century, physicists came to recognize a logical contradiction between two basic aspects in micro-physics:

"1- "PLANCK- in order to derive the empirical laws of black body radiation- had to assume that electromagnetic radiation is exchanged in discrete units, apparently in contradiction with the classical theory, which considered electromagnetism to be carried by continuous **fields** of waves.

"This concept was elaborated by EINSTEIN, who introduced the concept of a photon as a discrete, particle-like unit of electromagnetic radiation.

"2- Shortly thereafter, an opposite **phenomenon** was observed: electrons, which were considered to be particles, appeared to undergo interference, which is typical of **waves**. This double phenomenon... was called the **wave-particle duality**.

"The statement that something is at the same time a particle, hence discrete or **discontinuous**, and a wave, hence **continuous**, is a logical contradiction.

"The prevailing attitude toward this problem (known as the Copenhagen interpretation) was formulated most prominently by BOHR. According to BOHR, we cannot know physical reality as it is, independently of ourselves. We can only make certain **representations** of our **interactions** with physical systems. These **representations** are necessarily formulated in the **language** of classical physics. In the case of macroscopic **phenomena**, however, there is no complete and consistent classical **representation**: There are only partial **representations**, such as the wave **representation** and the particle **representation**, which are complementary. Complementarity means that the **representations** are mutually exclusive yet they are jointly necessary (they complement each other) for an exhaustive description of the physical **phenomenon**" (F. HEYLIGHEN, 1990b, p.479).

This problem in the **perception** of our **environment** (already considered by some philosophers – Western and Eastern) only appeared when our research started to interfere significantly with the **phenomena** we are studying, i.e. when the **observation** act give itself on the same **scale** or **level** of the **phenomena**. It shattered our belief in our capacity to reach **ontological** reality and it made us understand that our **interactions** with our **environment**

are not neutral. This **understanding** propagated itself slowly to every scientific research and became part of the foundations of **constructivism**.

Another consequence has been that **models** in micro-physics, astrophysics and generally every discipline widely separated from our common macroscopic **scale** of **perceptions** are becoming completely abstract and untranslatable in common sense **concepts**.

In J. HORGAN's words BOHR "... held that wave-particle duality is a **paradox** that cannot be resolved. BOHR also ruled out the possibility that the probabilistic **behavior** of quantum systems was actually the result of underlying **deterministic** hidden **variables**. Reality was unknowable because it was intrinsically undefined, BOHR insisted".

HORGAN pursues: "In 1952 BOHM defied BOHR's prohibition against hidden-**variable** explanations".

In fact, he reintroduced L.de BROGLIE concept of the permanent existence of particles, guided by a pilot wave. According to HORGAN, BOHM'S introduction of a new force, the quantum potential "was **causal**, or **deterministic**. Particles always had a distinct position and velocity, but any effort to measure these properties precisely would destroy **information** about them by physically altering the pilot wave. BOHM gave the **uncertainty principle** a purely physical rather than metaphysical **meaning**. BOHR had interpreted the **uncertainty principle**, BOHM explained, as meaning "not that there is **uncertainty**, but that there is an inherent **ambiguity**" in a quantum system".

BOHM's interpretation did however revived the EINSTEIN-PODOLSKY-ROSEN paradox, which HORGAN states as follows: "According to the standard **model** of quantum mechanics, neither of two particles (that spring from a common source and fly in opposite directions) has a definite position or momentum before it is measured; but by measuring the momentum of one particle, the physicist instantaneously forces the other particle to assume a fixed position – even if it is on the other side of the Galaxy".

EINSTEIN derided "...this effect as "spooky action at a distance"... that violated both common sense and the theory of relativity, which prohibits the propagation of effects faster than the speed of light".

This "spooky action at a distance" was however experimentally demonstrated by A. ASPECT and his Paris-South University group in 1982, following a mathematical proof by BELL, in 1964. Moreover, "...The reason that **nonlocality** does not violate the theory of relativity is that one cannot exploit it to transmit **information** faster than light or instantaneously".(1993, p.40-41).

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

This posits the general **irreversibility** of physical **phenomena** and could indicate the necessity of a still more global understanding, including relativity, quantum mechanics and **thermodynamics**.

All in all, BOHM's **nonlocality** as well as BOHR's **complementarity** and HEISENBERG's **indeterminacy** (or **uncertainty** ?) **principle** seems to thrust a shadow of doubt over our most fundamental **concepts** "...as **space** and **time** (which) may be merely explicate manifestations of some "nonlocal, deeper implicate order" according to BOHM" (Ibid., p.452).

Deterministic chaos, for instance, seems to lead to quite similar doubts about the deeper **meaning** of our mental **frames**. No systemic **ontology** can avoid these doubts about our possibility to attain true fundamental **knowledge** about reality.

0537

COMPLETION FROM WITHOUT Principle³⁾

"The ultimate inadequacy of any **control language** to perform its task can be remedied by the technique of inserting a **black box** in the **control circuit**" (After S. BEER, 1971, p.81).

The ultimate inadequacy referred to by BEER is, as he himself states, a result from **GÖDEL's Incompleteness Theorem**. His principle is based on the idea that: "The function of the **back box** is precisely to invoke the **decisions** of a higher **language**, which of course cannot by definition be expressed in terms of the **control language**, to repair the deficiencies of the original **decision-making** machine... The undecidable **language** is to be keyed in" to the real life it seeks to describe by an inherently indefinable **black box**" (Ibid).

This should be compared with J.van GIGCH's concept of **metasystem** and its use for "**decision making** about **decision making**" (1986).

0538

COMPLEX PHENOMENON²⁾

P. CORNING describes as follows the **attributes** of a complex phenomenon:

1. A complex phenomenon consists of many **parts** (or items, of units, or attributes)
2. There are many **relationships/interactions** among the **parts**
3. The parts produce combined **effects (synergies)** that are not easily predicted and may often be novel, unexpected, even surprising. (1998b, p.30)

0539

COMPLEX (Supremacy of the)^{1) - 2)}

H. SABELLI opposes in a dialectic way what he calls the "**priority of the simple**" and the "**supremacy of the complex**" (1994).

He means therewith that any complex **process** dominates and controls more simple ones, *but* that their existence is conditioned by the prior existence of the simpler ones. For example, the physical **processes** of the inanimate world are simpler than the biological ones, but, in an **organism** the physical **components** are organized by the physiological ones. SABELLI states: "It is thus, in principle possible to study the superior **processes** through the consideration of the **organization** of the simpler ones which constitutes them; reciprocally, to understand how the inferior ones are organized, it is necessary to consider the superior ones, which control them" (Ibid).

In this way, the analytic and the synthetic viewpoints become complementary and reciprocally needed.

0540

COMPLEX SYSTEM¹⁾

"A system made up of a large number of **parts**, that interact in a non simple way." (H. SIMON, 1965, p.63).

H. SIMON comments this informal definition as follows: "In such systems, the **whole** is more than the sum of the **parts**, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the **parts** and the laws of their **interaction**, it is not a trivial matter to infer the properties of the **whole**. In the face of **complexity**, an in-principle **reductionist** may be at the same time a pragmatic **holist**" (p.63).

One should add that the complex system is altogether in some sense *less* than the sum of its **parts**, since these always abandon some of their properties, as they become inhibited by some **constraints** resulting of the global or some particular **interactions**.

The complex system is thus not merely *complicated*, as these **constraints** are generally of various kinds and *reciprocally constraining*. **Complexity** is organized and the complex system presents **organizational closure**.

Of course, from a different viewpoint, complexity is in the eye of the **observer**, as explained by R. ROSEN: "We are going to define a complex system as one with which we can interact effectively in many different kinds of ways, each requiring a different mode of **description**" (1977, p.229).

J.L. LEMOIGNE proposes the following nine characteristics each one of which increases the **complexity** of a system: 1) to be identifiable; 2) to be active; 3) to be **regulated**; 4) to be informed about its own **behavior**; 5) to be able to decide its own **behavior**; 6) to be endowed with **memory**; 7) to be able to coordinate its **behavioral decisions**; 8) to be able to imagine or conceive new possible **decisions** and 9) to be able to finalize itself (1990).

0541

COMPLEXIFICATION^{1) -4)}

Growing diversification in a system's **complexity**.

To become more complex, a system needs to enhance its internal **variety**. This is possible only by obtaining a richer internal combinatorics.

This can be obtained only by an increase of the number of **elements**, allowing for a factorial **growth** of possible combinations (if no new **constraints** are introduced).

It is debatable if all classes of systems are able to do this.

Only complex **social systems**, when still endowed with many "open ends", can conceivably become more complex, because they are more **open** and less integrated than biological systems for example, which are strictly submitted to **organizational closure**. In social systems, writes P.M. ALLEN "Complexification feeds on itself because it creates new **situations** and dimensions... **Fluctuations**, both in normal **behavior** in the real world, and in the mental maps of actors, explore **situations** which are richer than the reduced **description** of the world given by any solution of the **model**. These explorations can lead to **amplification** by the **non-linearities** in the system and hence to its structural **evolution**" (1982, p.59).

0542

COMPLEXITY¹⁾

(From Latin: complexus, i.e. containing)

Some definitions

According to common dictionaries

G. KLIR quotes Webster's Third International Dictionary, according to which complexity: "is the quality of being complex" i.e.:

"- having many varied **interrelated parts, patterns**, or **elements** and consequently hard to understand fully", or

"- marked by an involvement of many **parts**, aspects, details, notions, and necessitating earnest study or examination to understand or cope with" (1993, p.40).

For the American Heritage Dictionary, complexity implies: "...interconnected or interwoven **parts**... involved and intricate, as in **structure**". And: "**Complex** often implies many varying **parts**. **Intricate** refers to a **pattern** of intertwining **parts** that is difficult to follow. **Involved** stresses confusion arising from the commingling of **parts** and the consequent difficulty of separating them". Moreover "**Tangled** strongly emphasizes the **random** twisting of many **parts**".

G. KLAUS and H. LIEBSCHER's german *Wörterbuch der Kybernetik* gives a more formal definition: "The complexity *K* of a system is directly proportional to the number *n* of its **elements**, the number *z* of the possible **states** of these **elements** and the number *k* of **couplings** between the **elements**" (1976, p.314).

French and Spanish common dictionaries are much less precise and do not offer specific insights.

H. SIMON's views

K. BAUSCH has given a most general definition: "A systemic characteristic that stands for a large number of densely connected **parts** and multiple **levels** of **embeddedness** and **entanglement**"

This definition can easily accommodate for example stellar-planetary systems or **ecosystems**

1. Systems with numerous **components** may be considered complex. Thus the *cardinality* of a **set** can be used as a measure of complexity.
2. Systems with much *interdependence* between **components** are generally considered more complex than others with less *interdependence*.

3. **Undecidable** systems (GÖDEL, TURING) can be considered as complex in comparison to **deterministic** ones.

4. Complexity of systems can be measured by their **information** content in the sense of SHANNON and WEAVER.

5. In this context, "informational complexity" can be defined by the number of **parameters** or **symbols** needed for their definition.

6. "Computational complexity" refers to the number of calculus steps needed to resolve problems corresponding to a specific **class** (1977, p.507).

Some French views

1) "Complexity of a system depends on two factors:

the number of **elements** that constitutes it and, the number of **interrelations** among them" (J.L. LEMOIGNE – 1990a, p.91).

This definition is merely quantitative. It does not say anything about the *nature* of the **interrelations**.

2) According to E. MORIN, complexity implies **recursivity** and can be characterized by "a tangle of myriads of **inter-retro-actions**" (1984).

Here, the **structural** and **functional** nature of complexity is emphasized.

3) J.L. VULLIERME insists on the **hierarchical** character of complexity, that implies: "... a plurality of logical **levels**, **interdependent** but irreducible to each other" (1990, p.147).

Complexity is also in the eye of the **observer**.

4) B.de HENNIN defines complexity as: "the expression and manifestation of the potential and actual **behavior** of a system that an **observer** represents in a **model**".

Such a **model**: "...expresses, includes and connects what is probable and what is certain, what is organized and what is dubious" (1993, p.1492).

This author enumerates a series of conditions:

- The need for the system to be able to communicate
- The interactive **behavior** between the system and its **environment** (translatable into **digital** as well as **analogic information**)
- The presence of an **observer** interacting with the system
- The existence of a specific project of the **observer**
- The scientific rationality implicit in the project
- An **epistemology** in correspondance with the **model**

5) J.L. LEMOIGNE writes that it may be "... a property of the presently available **representation** of the system" (1990 b, p.109).

6) R. VALLEE states that it "... depends on the grain of **observation** and on the selected **resolution level**" (1990, p.240).

Many definitions of complexity have thus been proposed. They differ due to the very variable **viewpoints** of their proponents. It does not seem appropriate to exclude any: each contributes some specific angle, useful for the global understanding of what we mean by complexity.

0543

COMPLEXITY: A broader view ¹⁾

"The name we are giving to the condition of human beings, **objects**, **phenomena**, **process**, **concepts** and feelings because:

- a) they are difficult to understand or explain
- b) their **causes**, **effects** or **structure** are unknown
- c) they require either a great deal of **information**, **time** or **energy** to be described or managed or a huge coordinated effort on the part of the persons, equipment and machinery
- d) they are subject to a **variety** of **perceptions**, interpretations, reactions and applications that are often contradictory or disconcerting
- e) they produce **effects** that are simultaneously desirable and undesirable (or difficult to **control**)
- f) their **behaviour**, depending on the case, may be **unpredictable**, relatively **unpredictable**, extremely variable or "counterintuitive" (F. SAEZ VACAS, 1990, p.83).

Complexity is rather different from **complication**.

The latter can be simplified more or less easily by **classification**, **reduction** to some few types, as for example in MENDELEEV's periodic table of chemical elements.

Complication may merely be an aspect of complexity.

The periodic **classification** is a mere *consequence* of the complexity of **interactions** at the atomic and nuclear **level**.

The contrary of complexity is not simplicity: J.L. LEMOIGNE even proposes the neologism "implex" to characterize a unit that cannot anymore be decomposed, at least at the **level** of the intended research. For example, individuals would be "implexes" in **social systems**, irrespective of their biological complexity.

As stated by G. MIDGLEY, we may distinguish natural world complexity, social world complexity and internal world complexity. The first two ones are necessarily and selectively filtered by the third one. For this reason, according to MIDGLEY: "... it is the explicit **emergence** of **ontological** complexity that is the real challenge facing us" (1992, p.154). In the same vein, W. KARGL observes that a good systemic **understanding** should not aim "...at reducing complexity between system and **environment**, but seek to (discover) **order**, regularity and **invariance**" (1991, p.582).

Such a view is further developed by W.R. REEVES: "Complexity... is a **concept**... used to measure... the relative ratios of the following **semantic pairs**: **order** and **disorder**; confirmation and novelty; **predictability** and **unpredictability**; **redundancy** and **variety**; **signal** and **noise**; **constraint** and **chance**; **differentiation** and **undifferentiation**; **symmetry** and **symmetry breaking**; and **negentropy** and **entropy**" (1992, p.1101).

On the other hand, the condition described by F. SAEZ VACAS is also proper to **living systems** in general, to **ecosystems** (and even many physical systems, as for example, the solar system or the geosphere), societies, animal as well as human, small **organizations** as well as great corporations or nations, **men-machine systems**, and **brains** (of men and animals).

Besides, we already understand some general characteristics of **complex systems**, as for example:

- they are **multi-functional**: different **parts** attend simultaneously different needs. However there are **coordination** devices, which help to maintain **coherence**, strongly in individual systems (like a living being, as a **whole**) or loosely as in social **groups** of any kind.
- they maintain a relatively permanent **identity** during a more or less extended period of **time** (**entitiation**, **organizational closure** in individuals – some basic **templates** or **patterns** in social **groups**).
- they have an **adaptation capacity** in the case of individuals, or of **evolution** in the case of **groups**

It is possible to study complexity from **bottom up** or from **top down**, but the main subject must always be global **coherence** and the **interconnecting** devices which maintain it.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

Of course, as stated by R. VALLEE: "...it is difficult to speak of complexity in an absolute form and it seems more sensible to contemplate a perceived complexity, depending of the **observer** viewpoint, considering complexity as a **relation** between the observing system and the observed one" (1990, p.50).

In a quite similar way L. LÖFGREN introduces a d-complexity (**description**) and an i-complexity (interpretation), both obviously superposed by our own **level of knowledge** on the supposedly complex **situation** or system considered. (1977).

Here, **information** becomes a measure of complexity, as stated by H.T. ODUM (1983, p.169).

Thereupon we should still add a **modelization** complexity, due to the interferences of our mental and computational tools within the **representation** (for our specific ends) of the system or **situation**.

Viewed from another angle, we may say that complexity begins with **nonlinearity** and with a multiplicity of initial **situations** in various **parts** of the entity under study.

According to E. LASZLO: "On higher **levels** the amount of complexity that can be developed in a system is greater than on lower ones due to the greater diversity and richness of the **components** and **subsystems**" (1992, p.244).

This is related to the progressive build-up of **hypercycles**, which results of the appearance of potentially complementary **elements** in a given **level** and within a given **environment**.

This in turn is consonant with H. SIMON statement that: "Complexity frequently takes the form of **hierarchy**" (1965, p.64). In his terms, there is an "architecture of complexity".

Complexity cannot easily (if at all) be measured arithmetically, probably because it is **structural and functional**. It seems to be a geometrical and **topological** property of **emerging** systems becoming organized on higher **levels**. Thus, two or more systems of the same type could have somewhat different characteristics (for example, fossil ammonites), but be *at the same level* of complexity.

Complexity is not merely statistical **diversity**. In this case, what we observe is merely absence of some coherent **order**, not complexity. Of course, in some cases a very complex *explanation* could possibly be reached, but merely relative to not coherent **diversity**.

Increasing complexity in systems seems to be related to four different but somehow connected evolutive **processes**.

The first one is **dissipative structuration**, which starts to occur when a system is pushed through increasing **fluctuations** far from its **equilibrium level**, toward an **instability threshold**. This is the result of increasing **energy** intakes, excessive for the system as it is organized at the moment. This process must be compensated by a corresponding increase of

entropy production. It may lead to the destruction of the system or to the **emergence** of a new system at a higher **level of structural and functional organization**. Such a system would then stabilize at a corresponding higher minimal **level of entropy production**.

Increasing complexity also implies more numerous and intricate **relations** between more **elements**, i.e. the appearance of a new **level of sociality**, once the critical **threshold** has been crossed. This may correspond with an "increased computational ability" (N. PACKARD). There seem to exist a critical **population density of elements** of a same or of complementary **classes** leading to a kind of **implosion** provoked by a considerable **multiplication** in a limited or shrinking **space**. This changes the individual **behavior of elements** through more numerous, frequent and strong **interrelations**. This in turn, leads to a more and more organized new collective **behavior**, i.e. to the appearance of a new **social system** on a higher **level of complexity**.

Such a system obtains a higher degree of **control** upon extended surroundings, leading to more **stability, productivity and survival time**. Ants societies and beehives, as well as presently expanding human societies are examples.

It should be noted that more **control** on the **environment** means more capacity to obtain **energy inputs**, which leads us back to PRIGOGINE's **thermodynamics of irreversible systems far from equilibrium**.

The third interesting **process** is **criticality**, which seems to be related to "would be" systems. In cases of **avalanches** and other critical **threshold phenomena** of this type, no higher **level of organization** sets in, possibly because all **elements** are of the same kind, or because **energy** is uselessly and prematurely dissipated in a non-structuring way. **Colonial organisms** that alternately **aggregate** and **disaggregate**, as for example the well known **Dictyostelium discoideum**, or sponges, or locust swarms, seem to be a limit case.

The fourth intervening **process** is **semi-deterministic chaotic behavior**, which results from multiple **simultaneous local events** within any intricate **network of elements**. At any precise moment the non-instantaneous and uneven **propagation of effects** allows for a limited and temporary leeway of **indeterminism** anywhere in the **network**, while its *global behavior* remains generally coherent. This makes the systems **behavior** always somewhat unpredictable.

J.L. LEMOIGNE considers that such a basic **unpredictability** is in fact the hallmark of complexity (1990, p.304).

At the most general **level**, complexity could be a cosmic innovative **transformation** toward a more efficient **energy dissipation** and **entropy production process**, compensated by higher global **levels of organization**. Such a view

was introduced by A. LOTKA in 1924 as the ecological **concept** of the "**world engine**", according to which **energy** is most efficiently used in "cascades" throughout the global **ecosystem**. (1956, p.331).

D.L. HARRIS, quoting A.B. CAMBEL (1993), states: "CAMBEL establishes and names three **categories**: the first is "**static complexity**", to include **purpose** and **function** as well as **size** and **configuration**. The second is "**embedded complexity**", consisting of **structure** and including composition and makeup. The third is "dynamic complexity" – a **category** to include various types of **dynamics**. Building upon the **categories**, CAMBEL then constructs fifteen **heuristic** statements, presented here in somewhat abridged form:

"1. Complexity may be found in natural and man-made systems, including social **structures**.

"2. Large and small **components** can live cooperatively in the same complex **dynamical system**.

"3. Physical shape may be regular or irregular.

"4. In general, the larger the number of systems **parts** the more likely the occurrence of complexity.

"5. Both **energy-conserving** and **energy-dissipating** systems can be subject to complexity.

"6. The system is neither completely **deterministic** nor completely **random**, exhibiting both characteristics.

"7. Causes and effects of system **events** are not proportional.

"8. **Parts** of complex systems are linked and affect one another in a **synergistic** manner.

"9. There is **positive** or **negative feedback**.

"10. The complexity **level** depends on the character of the system, its **environment**, and the nature of the **inter-action** between them.

"11. Complex systems can exchange **matter, energy and information** with their surroundings.

"12. Complex systems tend to undergo **irreversible processes**.

"13. Complex systems are dynamic and **not in equilibrium**; they may pursue a moving target.

"14. Complex systems frequently undergo sudden **changes**, suggesting that the **functional relations** that represent them are not **differentiable**.

"15. **Paradoxes** exist, such as organic and inorganic bodies in cohabitation; fast and slow **events**, etc." (1994, p.73).

0544

COMPLEXITY (Accumulative)^{2,4)}

C. HASKINS has observed that complexity in living beings and in insects societies grows out of **accumulation** (1946). In a way, this was already a basic tenet of E. HAECKEL's views of **evolution** with his fundamental biogenetic law: "**Ontogenesis**

recapitulates **phylogenesis**". **Evolution** does not start at any time from scratch: it results from adding new and not contradictory characters to those already in existence. This means that complexity self-constructs from **level** to level. According to Haskins each higher social level of **structures** results of a more or less similar **pattern**. Social forms imply specific types of **interactions** among reciprocally compatible individuals. And once initiated, they tend necessarily to develop coherently (i.e. in a non-contradictory and functional way)

HASKINS considers that human social world similarly tends toward higher degrees of complexity and that this can be seen specially through the cultural evolution of human societies from simpler **forms** toward more and more differentiated and coherently organized ones.

→ **Cross-level research; Priority of the simple; Recursivity; Supremacy of the complex; Zero System**

0545

COMPLEXITY (Algorithmic)²⁾

R. RUTHEN writes: "Some of the best ideas for defining and measuring complexity emerged from the work of Claude E. SHANNON, Andrei N. KOLMOGOROV and Gregory J. CHAITIN during the 1950s and 1960s. They proposed that the degree of complexity is related to the size of the smallest **description** of a system's **behavior**. This theory led to a proposed technique for measuring the so-called **algorithmic complexity** of a **process**. In theory, the complexity of two systems could be compared by writing two computers **programs** that are the shortest capable of reproducing the original **data**... The **program** with the fewer instructions would describe the less complex system" (1993, p.114).

The same idea was expressed by V.G. DROZIN: "The complexity of a system can also be expressed by the number of steps of a prescription or **algorithm** needed to assemble the **whole** from its **parts**.... Indeed, the greater the **variety** of **parts** and their number,... the longer will be the algorithm needed for its assembly".

And still: "(The) expressions of complexity of a system are reducible to the number of its non-interchangeable **states** and can be linked to the **negentropy** content of the system" (1975, p.9).

An original view is R.V. JENSEN's, who states: "The theory of algorithmic complexity reveals that the origin of **chaotic behavior** in **nonlinear dynamical systems** and perhaps in nature itself lie in the **randomness** of almost all real numbers" (1987, p.178).

→ **Numbers (rime)**

However, if a system is very complex (or if the **level** of our analysis is high) we are led to **algorithmic incompressibility**, or in other cases, to the practical impossibility to compute because we would (in accordance with **BREMERMAN'S limit**) "literally have to wait from now to eternity to find out the results" (Ibid).

0546

COMPLEXITY (Algorithmic)

→ **Algorithmic complexity**

0547

COMPLEXITY (Algorithmically incompressible)^{2) - 3)}

J. BARROW states "There exist complex **phenomena** whose **evolution** through **time** cannot be represented by any abbreviated formula, so that the most succinct **representation** of their **information** content is nothing less than their complete **history**" (1991, p.60).

In such cases, no abbreviated statements of **invariance** are possible.

0548

COMPLEXITY as perceived^{1) - 3)}

As observed by R. ESPEJO: "Individuals only see 'sides of a **situation**', never the whole of it; indeed, there is no **viewpoint** that can capture in full the **variety** of a **situation**. Different **viewpoints** 'see' different **chunks** of **variety**, and no **viewpoint** can see the full **variety**, not least because human **activities** are constantly being created and recreated by the people participating in them" (1988, p.139). And: "Outcomes are related to **patterns** in **time** (i.e. **behaviours**), and the complexity of the **situation** is defined by the number of non-equivalent outcomes recognized by the **viewpoint** in the **situation**" (p.140).

In ESPEJO's words, **viewpoints** act as "**cognitive constraints**".

Perceived complexity is thus merely an aspect of total complexity, which could be equated with the **variety** in the system or **situation**. Moreover, it is always a transitional reflection of the same, because all **situations** and systems are permanently changing. In ESPEJO's words: "... perceiving complexity has a **time** dimension, and... the history of **viewpoints** is essential to work out the outcomes of a **situation**, that is, to work out its complexity" (p.144).

This implies that:

- a broader **range** of **viewpoints** gives a deeper **understanding** of the system or **situation**, as observed in different ways by J. WARFIELD (**Nominal Group Technique**), B. BANATHY and the FUSCHL Group (**Co-participative design**) or J. JOHANNESSEN (**Heterarchy**).

- a satisfying **consensus** between **viewpoints** gives a more accurate global view of **complex systems** or **situations**.
- frequent reviews of the different **viewpoints** allow for a progressive deepening of **understanding** of complexity.

0549

COMPLEXITY (BOULDING's 8 levels of)¹⁾

K. BOULDING proposed a "...**hierarchy** of complexity, roughly corresponding to the complexity of the "individuals" of the various empirical fields" (1956, p.14-15).

The levels are as follows:

- 1 - The level of the static **structure**, or frameworks, "whose accurate **description**... is the beginning of organized theoretical **knowledge** in almost any field"
2. - The level of clockworks, "... simple **dynamic systems** with predetermined, necessary motions... Such a system may reach a position of **stationary equilibrium**, or it may not - there are plenty of examples of explosive **dynamic systems**"
3. - The level of the **control mechanism** or **cybernetic system** in which "... the **transmission** and interpretation of **information** is an essential **part** of the system... The **homeostasis model**... is an example of a **cybernetic mechanism**"
4. - The level of the "**open system**" or self-maintaining **structure**. "This is the level at which life begins to differentiate itself from not-life. However "Something like an **open system** exists, of course, even in physico-chemical **equilibrium** systems", wherein "**structures** maintain themselves in the midst of a **throughput** of electrons, molecules, etc..."
5. - The genetic-societal level, which is typified by the plant. "The outstanding characteristics of these systems are first, a division of labor among **cells** to form a **cell-society** with differentiated and mutually dependent **parts**... and second, a sharp difference between the **genotype** and the **phenotype**, associated with the **phenomenon** of equifinal or "blueprint" **growth**". See **grammar**, **program**.
6. - The animal level, "characterized by increased mobility, **teleological behavior** and self-awareness". As we ascend the scale of animal life, **behaviors** become more diversified, complex and coherently integrated.
7. - The human level: "... the individual human considered as a system... In addition to all, or nearly all, of the characteristics of animal systems, man possesses self **consciousness**, which is something different from mere awareness". **Self-reflexivity** is "... bound up with the **phenomenon** of language and symbolism"
8. - The level of social **organizations**. "The unit of such systems is not perhaps the person - the individual human as such - but the "**role**" - that part of the person which is concerned with the **organization** or **situation** in question"

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Like any other classification, BOULDING's one can be questioned. It is however to be noted that, after nearly 40 years, it has not been basically contradicted by any subsequent experimental or theoretical development.

0550

COMPLEXITY (Conceptual framework for)³⁾

R.L. FLOOD finds that systemic complexity depend on a number of characteristics as follows:

1- The system must include numerous **parts**
 2- These parts must have numerous cross-relations or **interrelations** but must also have **degrees of freedom** (i.e. not be submitted to **constraints** so stringent that it becomes blocked)

3- Quite generally, the system is **non-linear**

Here FLOOD comments: "A feature of **non-linear** systems is that different starting points can cause the system to become **unstable**. They are generally very difficult to understand and commonly "display" **counter-intuitive behavior**, a characteristic of our inability to comprehend **complex systems**" (1987, p.180).

4- The system is generally **asymmetric**, as a result of differential **growth**.

5- The system generally presents non-**holonomic constraints**.

FLOOD comments: "...**parts** of the system are temporarily outside central **control** and can in fact go off. Complexity may therefore arise when there is some sort of localized transient **anarchy** in the system" (p.181).

6- Complexity is also characterized by **hierarchy**, which means that the system's **organization** includes various **levels**, **structurally** different, needed for **regulation** and **control**.

7- Complexity may appear or grow through **emergence**, i.e. the shaping of **organization** at a **meta- or supra level**.

All this is intrinsic complexity. However at human **level of perceptions, values** and **beliefs** still a new **level** of complexity appears" (p.182-3).

0551

COMPLEXITY (Degree of)²⁾

"... the number of distinct **structures** in which various mutual **couplings** can arrange the system's **elements**" (R. FIVAZ, 1991, p.24).

According to FIVAZ: "... the **evolution** of the **complex system** can be seen as an indefinite **sequence of transitions** which activates **structures** and associated **functions** according to external opportunities" (Ibid).

Instead of "**evolution**", it would possibly be better to speak of "**progressive adaptation**".

From another viewpoint, as in H. SIMON **Hora and Tempus parable**, complexity also has a **hierarchical dimension**.

0552

COMPLEXITY (Factors of)¹⁾²⁾

G. WENG et al. write: "In physical systems, complexity is determined by such factors as the number of **components** and the intricacy of the **interfaces** between them, the number and intricacy of conditional **branches**, the degree of **nesting**, and the types of **data structures**. Biological signaling **networks** possess many of these **attributes**, as well as dynamic assembly, **translocation**, degradation and channeling of chemical reactions. All of these **activities** occur simultaneously, and each **component** participates in several different activities" (1999, p.92).

This description, based on the study of molecules and **cells**, seems applicable mutatis mutandis, to all kinds of **social systems** in general.

The distinct **elements**, attributes and types of relationships would have to be identified and described at this higher **level** of complexity

0553

COMPLEXITY from noise principle²⁾

H. ATLAN explains: "These two opposite properties (i.e. **redundancy** and **variety**) appears both as obvious features of what is **organization** and therefore, a good theory must take them both into account in such a way that an optimal **organization** will appear as a kind of compromise between maximum **order** or **redundancy** and maximum **disorder** or **complexity**."

"From then on, it is possible to see how **random perturbations** can produce a change in **organization** by reducing the **redundancy** and increasing the **complexity** of a system, at least, up to a certain point, as long as there is enough **redundancy** to keep the system going.

"This is the so-called complexity from noise principle, at the root of the formal theory of self **organization** that I have worked out several years ago" (1972, p.28-30).

Equivalence between maximum **order** and **redundancy**, or maximum **disorder** and **complexity** is debatable. Maximum **disorder** is generally considered as a completely **random state** or **behaviour** of very numerous **elements**, which is complex only if one considers the massive necessity of **information bits** to describe it. Conversely **redundancy** is **order** only if order is defined as maximum **homogeneity** or uniformity. All this could lead to a serious **semantic muddle**.

0554

COMPLEXITY (Laws of)^{1) - 3)}

J. WARFIELD enunciates 17 "laws of complexity" (1995 a, p.123-52), which he discusses extensively (For details see reference - for many of the **concepts** involved see corresponding entries). The so-called laws are in fact mainly directing **concepts** and principles for the study of

complex issues by **groups**. They should thus be better termed: "Principles for the study of complex issues". Hereafter a somewhat condensed and adapted statement of these "laws"

- "**Triadic compatibility**: The human mind is compatible with the demand to explore **interactions** among a **set** of three **elements**, because it can recall and operate with seven **concepts**, these being three **elements** and their four combinations.

- "**Requisite parsimony**: Every individual's **short-term brain activity** lends itself to dealing simultaneously with approximately seven items... (Law of **triadic compatibility**). Attempts to go beyond this scope of reasoning are met with physiological and psychological **limits** that preclude sound reasoning.

- "**Structural underconceptualization**: No matter what the complex issue, and no matter what the **group** involved in its study, the outcomes of ordinary group **process** (i.e. **process** in which computer support for developing the formal logical **structure** of the issue is lacking) will be structurally **underconceptualized**.

- "**Organizational linguistics drift**: As an organization grows, linguistic separation grows both laterally and vertically in the **organization**. At the higher vertical **levels**, **metaphors** and **categories** become progressively disconnected from the relevant **components** at lower **levels**, leading to **decisions** based on perceived **relations** between **categories** that are not borne out by the **relations** between **category** members.

- "**Validation**: The validity of a science depends upon substantial agreement within the scientific community of **meaning** at its highest grade, i.e. **meaning** attained through **Definition by Relationships**.

- "**Diverse beliefs**: Whatever the **group**, whatever the complex issue being considered by the **group**, at the outset of **group** consideration of the issue, the individual members of the **group** will have quite diverse beliefs about the issue, and the probability is high that this **situation** will remain undiscovered and uncorrected, in the absence of a **group learning** experience using a **methodology** whose power to produce the necessary **learning** has been scientifically validated.

- "**Gradation**: Any conceptual body of **knowledge** can be graded in stages, such that there is one simplest stage, one most comprehensive stage (reflecting the total state of relevant **knowledge**), and intermediate stages whose **content** lies between the two extremes.

(Warfield draws three corollaries from this "law": a corollary of relative **congruence**, one about **diminishing returns** and one about the need to restrict "virtual worlds").

- "**Universal Priors**: The human being, **language**, reasoning through **relationships**, and archival **representations** are universal priors to science" (i.e., there can be no science without each of them).
- "**Inherent conflict**: No matter what the complex issue, and no matter what the group involved in its study, there will be significant inherent **conflict** within the **group** stemming from different **perceptions** of the relative significance of the factors involved in the complex issue".
- "**Limits**: To any **activity** in the universe there exists a corresponding **set** of **limits** upon that **activity** which determines the feasible extent of the **activity**. (Here again, WARFIELD states corollaries):
Corollary of active limits: For any particular **situation**, the **set** of **limits** can be partitioned into two blocks: an active block and an inactive block;
Corollary of movable limits: The **set** of **limits** can also be partitioned into these two blocks: movable and fixed;
Corollary of discretionary action: The movable **subset** of **limits** can be partitioned into these two blocks: movable through discretionary **action** by people, and **autonomously** movable;
Corollary of shifting limits: The membership of the active blocks and the inactive blocks of the **partition** changes with **time**.
- "**Requisite saliency**: There is an underlying logic awaiting discovery in each **design situation** that will reveal the relative saliency of (the various) situational factors.
- "**Success and failure**: There are seven critical factors in the "success bundle" for the **design process**. Inadequacy in any one of these factors may cause failure. The seven factors are: leadership, financial support, **component availability**, **design environment**, designer participation, documentation support, and **design processes** that converge to informed agreement.
- "**Uncorrelated extremes**: No matter what the complex issue, and no matter what the group involved in its study, the *initial* aggregate **group** opinion concerning the logical **pattern** of the factors involved in the issue and the *final* aggregate **group** opinion concerning the logical **pattern** of the factors involved in the issue (i.e., the views at the two extremes of the application of the **Generic Design Science**, before and after) will be uncorrelated; showing that significant **learning** can take place through the application of the **generic design process**.
- "**Requisite variety**: A **design situation** embodies a requirement for **requisite variety** in the **design** specifications. Every **design situation** S implicitly represents an (initially unknown)... dimensionality such as either:

- 1) the **behavior** of the target is outside the **control** of the designer (the target is under-specified), or
- 2) the **behavior** of the target cannot be compatible with the designer's wishes (the target is overspecified).

Only if the **behavior** of the **design** should be what the **situation** can absorb and which the designer can **control**, can the **design process** apply the law of **requisite variety** iteratively, taking in account the **dynamics** of the **situation**.

- "**Forced substitution**: **Underconceptualization** and inherent **conflict** lead to policy vacuums in an **organization** into which authority injects forced **substitution** for absent and inadequate conceptualization, in order to avoid institutional paralysis and for self-protection.
 - "**Precluded resolution**: Forced **substitution** in organizations is dominated by the combination of:
 - structural **underconceptualization**
 - inherent **conflict** and diversity of beliefs
 - dysfunctional **organizational linguistics**, which combine to preclude resolution of complex issues.
 - "**Triadic necessity and sufficiency**: **Relations** are characterized by the number of distinct relational **components**, but no matter how many such **components** a **relation** may have, the (complex) **relation** can always be expressed by **component relations** having no more than three relational **components**; but **triadic relations** exist that cannot be expressed in terms solely of **dyadic** and **monadic relations**".
- This last proposition quite unexpectedly at first sight seems to be related with the **three bodies problem**.

0555

COMPLEXITY (Limits to) ¹⁾

I. PRIGOGINE states this problem in the following way: "The more **elements** that are in **interaction**, the higher the degree of the secular equation determining the characteristic **frequencies** of the system... The greater will therefore also be the chances of this equation's having at least one positive root and hence indicating **instability** (1976, p.123).

H. SIMON, in turn, through his famed parable of the two watchmakers **Hora** and **Tempus** showed how complexity may increase through **hierarchization** of **processes** and **structures**.

The **instability** problem is also subtly related to the **hierarchy** of complexity, since a more global **dynamic stability** may include local **domains** of attraction specifying "islands" of **stability**.

0556

COMPLEXITY (Mathematics of)

→ **Mathematics and Systemics**

0557

COMPLEXITY (Multi-level vs multivariate) ²⁾

T. BAUMGARTNER et al. oppose multi-level to multivariate complexity "... which simply adds more **variables** to the system at the same **level**" (1976, p.38).

According to these authors, a **variable** or **process** at a higher **level** within the system and over some period of **time** "... maintains or is likely to change the **relationships** among the **variables** already considered to be descriptive of the system" (Ibid).

While the **distinction** between higher and lower **hierarchic levels** is important and admittedly, in general **asymmetric** in favor of the higher ones, it seems quite possible that, in some cases, a **variable's** erratic **behavior** at a lower **level** may have general **effects** on the system as a **whole**. This seems specially true in the **social systems** researched by the authors ("For the want of a horseshoe, the battle was lost").

0558

COMPLEXITY of systems ¹⁾

H. SIMON enumerates the following criteria of complexity in systems:

- " 1. Systems with many **components** may be considered complex compared with systems which have few. Thus the cardinality of a set may be considered as a measure of its complexity
2. The systems where there is much **interdependence** between **components** are generally considered more complex than those with less **interdependence** between them
3. Systems which are "undecidable" may be considered complex when compared with **deterministic** ones
4. Complexity of systems may be measured by their **information content**, in the sense of SHANNON-WEAVER. By this **criterion**, systems with many identical **components** are less complex than systems of similar size whose **components** are all different" (1990, p.126).

SIMON also points out that one may also speak of complexity of theories or problems, for example:

- according to the number of **parameters** or **symbols** needed in a theory
- according to the number of elementary **operations** that must be computed in **order** to solve some type of problem
- in relation with computational complexity.

0559

COMPLEXITY (Organized) ^{1) - 2)}

The existence of a **set** of **intermittent** or permanent **interrelations** between a number of interconnected **components**.

The concept was introduced by W. WEAVER. It "involves systems with large number of **components**, rich **interactions** among the **components**, and some degree of **nondeterminism**. They are typical in life, behavioral, social and environmental sciences, as well as in applied fields such as modern technology or medicine" (G. KLIR, 1993, p.35).

Organization is closely related to complexity. In K. DENBIGH's words: "An organized system consists of **parts** and **sub-parts** and these are **interconnected**" (1975, p.85). This author stresses moreover that, "as one cannot speak about something being organized without at one raising the issue, what is it organized for?" (Ibid), organized complexity implies the idea of **function** or **process**.

According to A. RAPOPORT: "Mathematically an "organized complexity" can be viewed as a **set of objects** or **events** whose **description** involves many **variables**, among which there are strong mutual **interdependencies**, so that the resulting system of equations cannot be solved "piece-meal", as in the case of classical celestial mechanics, where **perturbations** can be imposed on **two-body problems**" (1966, p.4).

E. LASZLO writes: "... such **relations** cannot be treated with mathematical rigor with the classical **concepts** (which soon encounter their limitations in the "**three body problem**")" (1992, p.5).

The **holistic** approach has been one of the first new methodological proposal to the study of organized complexity.

It became however rapidly confronted with tricky problems of "inverted **reductionism**" and the resulting useless controversies between "**generalists**" and "**specialists**".

The need to bridge this chasm has led to practically all the **general systems models** developed to date and to the appearance of new mathematical tools as for example **graphs**, **catastrophe theory**, **deterministic chaos**, etc.

0560

COMPLEXITY REDUCTION ²⁾

The main problem for the **survival** of any system is the absolute necessity to adapt and constantly readapt itself to everchanging conditions in its **environment** (and **invironment**).

O. THYSSEN (1995, p. 16) expresses this as follows: "Because of the impossibility of (perfectly) mirroring the environment (or the system itself) in the system, an autopoietic **system** must develop **structures** in order to reduce complexity and create viable simplifications. The means of *reducing* complexity are at the same time the means of *producing* ordered complexity"

→ **Model; Regulator Identity; Reference frame; Variety (Law of requisite); Variety and complexity**

0561

COMPLEXITY THEORY ^{1) - 2)}

Complexity has been first considered under the following aspects:

- **Organismic complexity** as described by L.von BERTALANFFY in his fundational work based on biology.
- **Structural complexity** as for example by J. MILLER in his "**Living Systems**", including the study of **critical subsystems** and the different **levels** of complexity.
- **Hierarchic complexity** as for example by K. BOULDING in his **classification** of systems, or H. SIMON in his "Architecture of complexity"
- **Dynamic complexity** as first considered by H. POINCARÉ in his **three bodies problem**, a work whose all-embracing importance was not understood until the emergence of **chaos** theory.

A more elaborated theory of complexity appeared in recent years, particularly through the work of St. KAUFFMAN, J. HOLLAND, C. LANGTON and others, who see, as any systemist, complexity as the result of **interactions** between **elements**, but are unraveling the ways these interactions work through the study of the **behavior** of **networks**, according to variegated individual **rules**.

Complexity has also been considered from a new viewpoint in **thermodynamics of irreversible systems** by I. PRIGOGINE and the Brussels and Austin's teams which he organized.

→ **Artificial life, Connection machine, Network behavior, Neural network**

0562

COMPLEXITY THRESHOLD ^{1) - 2)}

According to J.von NEUMANN, there is a specific **level** of complexity ("complication", in von NEUMANN's terminology - unfortunately) below which the system spontaneously degenerates into a simpler one and above which it tends to evolve toward a higher degree of complexity.

Such a threshold seems to be related to increasing energy **flows** and thus to PRIGOGINE's **thermodynamics of irreversible systems**, either those dynamically stable, or those affected by **dissipative structuration** through giant **fluctuations**. Implications for the present **transformations** of human societies are considerable, as noted by R.N. ADAMS (1988).

0563

COMPLEXITY (Time Dimension of) ²⁾

According to J.W.S. PRINGLE, the notion of complexity should include not only the **synchronic** complexity of **forms** and **structures**, but also the **diachronic** complexity of **processes**. He expresses this opinion as follows:

"The complexity of the **description** of the **behavior** resides in the number of independent **rhythms** into which it can be analyzed" (1956, p.95).

He thus characterizes the difference between **synchronic** and **diachronic** complexity: "Instead of distinct **parts** of the system which preserve their separateness with the passage of **time**," (i.e. whose **synchronic interrelations** remain invariant at different moments) "we now need to have distinct **rhythms** which remain distinct as they move through the **population**" (p.98).

0564

COMPLEXITY (Unorganized) ²⁾

The statistical **relations** between a great number of seemingly not causally ordered **elements**.

According to I. BLAUBERG, V. SADOVSKY and E. YUDIN: "(Classical science) was chiefly concerned with solving two-**variables** problems, establishing the **causal relations** between two **phenomena**, determining **linear** causal chains for a relatively small number of **objects**" (1977, p.200).

As noted by these authors, this was basically deductive science, and could not cope with "... the problem of discovering the diversity of links and **relations** existing inside the analyzed **object** and its **interactions** with other **objects**" (p.201).

The closest approach to this type of problems was classical statistics, whose laws are basically quantitative and allow merely to tally, classify and extrapolate or interpolate (without much security), i.e. look for some hidden order within "a great number of seemingly not causally ordered **elements**", as for example in **composite systems**.

The expression "Unorganized complexity" was coined by W. WEAVER in 1948, and commented by him as referred to problems "...in which the number of **variables** is very large, and in which each of the many **variables** has a **behavior** which is individually erratic, or perhaps totally unknown. However,... the system as a **whole** possesses certain orderly and analyzable average properties".(1948, p.536).

In G. WEINBERG's words such systems being "...sufficiently **random** in their **behavior**... are sufficiently regular to be studied statistically" (1975, p.16).

WEAVER observed however that in this way, the enormous **domain** of systems with more than two, but less than an astronomical number of **variables** was still left untouched (Ibid). **Chaos theory** is now progressively covering this ground. (See G. BROEKSTRA, 1994, p.1099).

0565

COMPLEXITY (Unwarranted)^{2) - 3)}

A groundless complexity in **modelling codes**.

J.L. LE MOIGNE states: "Many **phenomena** initially perceived as complex (nearly unintelligible or non correctly representable) seem suddenly to become comprehensible when modelers change the **description code**... The Martian orbit that KEPLER desperately tried to describe at the cost of 900 pages of calculation, through a peculiarly complex epicycloid... turned suddenly easy to describe and interpret once the Ptolemaic **code** and the Copernican one of celestial spheres... were replaced by the elliptic **code**" (1990, p.301).

This type of roadblocks to **understanding** is quite frequent. It should however be observed that the inverse situation does exist: Hamiltonian **models** were too simple to explain and modelize **chaos**, as first demonstrated by POINCARÉ.

0566

COMPLEXITY versus SIMPLICITY^{1) - 3)}

The concept of complexity evolved considerably during the 20th century. This historic process is thus described by R. LEFEVER and I. PRIGOGINE: "In the classical perspective, there was a clearcut **distinction** between what was considered to be simple and what had to be considered as complex: There was no hesitation about calling "simple" Newtonian laws of motion, perfect gas, or chemical reactions. Also, one would have called "complex" biological **processes**, and more so human **activities** such as described by economics or urban planning. In this perspective, the aim of classical science was to discover even in **complex systems**, some underlying simple **level**. This **level** would be the carrier of **deterministic** and **time-reversible** laws of nature: Future and past would play the same role. However, this basic **level** remained elusive. Today a far reaching reconceptualization of science is going on. Wherever we look, we find **evolution**, diversification and **instabilities**" (1986, p.2).

Systemics is, in many aspects, fundamentally a science of complexity. As a first step G. WEINBERG distinguishes:

- Organized simplicity (**machines**)
- Unorganized complexity (**aggregates**)
- Organized complexity (systems) (1975, p.18).

Roughly, organized simplicity corresponds to **lineal deterministic machines** (von FOERSTER's **trivial machines**).

Unorganized complexity corresponds to **random interactions** between a great number of **elements** and can be studied through statistical methods. Finally, organized complexity is proper to **nonlinear systems** and is the specific study domain of **systemics**.

0567

COMPLICATED VERSUS COMPLEX¹⁾²⁾

T.F.H. Allen writes: "Complexity needs to be parsed into two parts:

- 1) Complicatedness, and
- 2) Complexity of **organization**

"In hierarchical terms, complicated systems are strongly horizontally differentiated to make a flat **hierarchy**. Such systems exhibit complicated **behavior**

"As systems differentiate horizontally, they tend to differentiate vertically also, developing new **levels of organization** by an elaboration of organization"(1998, p. 5)

Good examples of this process are the **emergence** of a social **phase** in the amoeba *Dicystelium discoideum*, or the present **globalization process** in the **man-planet system**.

Allen adds: "In contrast to horizontal **differentiation**, increased vertical differentiation makes system behavior simpler by collapsing **degrees of freedom**, against the **constraints** coming from the upper **levels**"(Ibid)

0568

COMPLICATION (Principle of)^{1) - 2)}

"Unless some **threshold level of complexity** is reached, there can be no **evolution** of greater **complexity**; below this **threshold**, systems degenerate" (H. PATTEE, 1972, p.35).

It would have been better to call this principle: "Principle of **complexity threshold**"

While this principle is thus enounced by PATTEE, this author expresses his debt to J.von NEUMANN, who wrote (in 1956): "We are all inclined to suspect in a vague way the existence of a **concept** of "complication". This **concept** and its putative properties have never been clearly formulated. We are, however, always tempted to assume that they will work in this way. When an **automaton** performs certain **operations**, they must be expected to be of a lower degree of complication that the **automaton** itself... That is, if A can produce B, than A, in some way must have contained a complete **description** of B. In order to make it effective, there must be, furthermore, various arrangements in A that see to it that this **description** is interpreted and that the constructive **operations** that it calls for are carried out. In this sense, it would therefore seem that a certain degenerating tendency must be expected, some decrease in **complexity** as one **automaton** makes another **automaton**" (1956, p.2092).

An obvious consequence of this concept is the necessity for combinatory **heterogeneity** (genetic, sexual, social, etc...) if **complexity** is to be produced and extended.

An other consequence is that any **auto-poietic** system must contain a permanently usable "blueprint" or **template** of itself.

On the other hand, PATTEE himself comments, however, that: "The scientific **description** of **events** would, in fact, get nowhere in nature's maze of **complexity** unless there were repeated resimplifications which we call **hierarchical levels of description**" (Ibid., p.37).

As shown by J. MILLER in his "**Living Systems**", for example, systemic **isomorphisms** appear throughout the various levels of **description**.

0569

COMPONENT¹⁾

"A unit of a system that in combination with other units functions to combine, separate, or compare the **inputs** to produce **outputs**" (K. BERRIEN, 1968, p.32).

"An integral **part** of a system, selected on the basis of its potential to carry out **functions** required for the achievement of the system's **goal**" (B. BANATHY, 1973, p.85).

The BERRIEN's definition should be compared with J. MILLER's **subsystems**, mainly, but not exclusively, the **converter**, the **producer** and the **associator**. The **outputs** may be intra-systemic, for the use of other **subsystems**. It also seems that components may carry out other tasks in a system. BERRIEN emphasizes that a critical **proximity** is necessary for components to **interact**. He adds that "Once **embedded** in a system, the component to some degree becomes dependent upon the total system for its existence. The greater its specialization, the greater is the **dependence** of the component on the total system" (p.84).

The **distinction** of a component is partly a matter of viewpoint: A component can generally be viewed as a **whole** system when considered at a lower **hierarchic level**. A **cell** is a **complex system** in its own right, but in a living being it acts as a component, because it has entered in a **net of relationships**. In the same sense, a (complex) atom is a component in a molecule, and an individual, itself biologically a complex system, is a component in a **group** or **organization**.

Generally, components are integrated in some more or less permanent **structures**. However, in some cases they may be exchanged between two or more **subsystems** or even circulate more or less freely within the system. Nonetheless, the individual properties of the components become restricted as an effect of their **integration** within a specific system, while they may become associated with other components and produce some collective **behavior** which none of them could produce individually. This is why systemists say that a system is more (and less) than the sum of its components.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

In another aspect, the components of a system are frequently incompatible with other systems. This is the root of immunological rejection and probably, of feuds between nations, cultures, religions and races.

The reproduction **process** of self compatible components by the system is a basic part of the **autopoietic process**.

In relation to higher **levels** of **complexity**, components of lower **levels** frequently belong to a quite limited number of types. There are for example less than 100 basic types of atoms; only 4 nucleotides in DNA chains; and 20 amino-acids for the makeup of proteins. More examples are the basic **binary** units in **computers** or the 20-plus letters in most **languages alphabets**. As observed by H. SIMON, a small number of basic components at any **level** produces simplicity through **redundancy**. (see also: C. BRESCH, 1977).

0570

COMPONENT (Central) ¹⁾

"A component... whose inhibition results in the failure of the entire system" (R. ROSEN, 1960, p.32).

This definition relates obviously to centralized systems and underlines their main cause of fragility, which can be witnessed in many authoritarian **organizations**.

However, even in partly decentralized or **heterogeneous** systems the loss of the central component of critical **subsystems** may provoke the demise of the whole system, as for example the disabling of the **brain**, heart or (both) kidneys in a biological system.

0571

COMPONENTS (Complexity in) ^{1) - 2)}

A characteristic of components made of other components of lesser complexity.

For example, molecules are made of atoms, **cells** are made of molecules, **groups** and societies are made of individuals.

Complexity in components is not merely the result of an additive **process**, as it manifests itself by the appearance of **emergent** properties resulting of the new and specific **interconnections** among the newly associated **elements**.

The assembly of complex components seems to be related to complementary **dis-symmetries**, that may even be **antagonistic**, as long as they are not incompatible. Minimal **sets** of potentially functional assemblies of components have been called '**autogenetic systems precursors**' by V. CSANYI (1989, p.76).

0572

COMPONENTS (Cooperative) ²⁾

Components which maintain **interrelations** with other components in a **network**.

A **network** is normally characterized by allowed **interrelations** while other ones are avoided through **constraints**.

Cooperative **interrelations** of components, when sufficiently observable, can frequently be represented by a **matrix** of stable **transitions**.

0573

COMPONENTS (New) ²⁾

Ch. WALTER thus defines the survival condition of any new components in **populations** (in the LOTKA - VOLTERRA sense, but it seems also valid for components of strongly integrated **living systems**, as **cells**, for instance): "If the new component is to survive, it must interact with its **environment**, and it must maintain itself by a **replication process** that balances the natural **processes** of **dissipation** and **decay**" (1974, p.216).

"Replication" should be understood as **self-reproduction** in the autopoietic sense.

In other words, the new component must be at the same time **adaptable** and **autopoietic**.

0574

COMPONENTS (Unreliable) ²⁾

A great number of unreliable components can become organized in a reliable system through **redundancy** and variability of their **interconnections**.

This field of research was opened by J.von NEUMANN in his 1956 work on "Probabilistic logic and the synthesis of reliable **organisms** from unreliable components".

0575

COMPOSITE SYSTEM ^{1) - 2)}

A system composed of weakly interacting **elements**, all of them of the same **class**.

Such systems should better be named para-systems or quasi-systems because they lack a number of properties characteristic of more **integrated systems**, as for example:

- they have no definite **function**
- they have no **subsystems**
- they are not **autopoietic**, nor **autonomous**
- they are **homogeneous**

Heaps of sand, accumulations of snow in mountains, flowing fluids, stock markets, **populations** and possibly star **clusters** are examples of composite systems. Their basic property is **self-organized criticality**, which makes them subject to runaways and crashes.

0576

COMPRESSIBILITY ^{1) - 3)}

The possibility for an **observer** to reduce the **complexity** of the real world by constructing **algorithms** which produce an ordered and simplified **understanding** of a number of **phenomena**.

J. BARROWS explains: "If it is possible to store the **information** in an abbreviated form shorter than the sequence itself, then the sequence is regarded as non**random** and we call it compressible". If no such abbreviation exists, then the sequence admits no **representation** other than the complete explicit print-out of itself. In this case, we call it "incompressible".

"... this notion of compressibility gives simple ways of characterising many of our intellectual activities. We recognize a possible new definition of "science" as being simply the search for compressions: the laws of Nature are the compressions of our sense **data**. The discovery of a "Theory of Everything" would be the ultimate compression. Moreover, the apparent success of this **process** hinges upon two superficial features of things: the physical world that we observe seems to be surprisingly amenable to compression, and the **brain** is remarkably good at effecting compressions when presented with **events**.

"Clearly, this compressibility and the **brain's** remarkable ability to make sense of complicated things is an important necessary condition for our own existence. We could not survive as "intelligent" **observers**... in a world where no compressions were possible, or with **brains** that produced imaginary or erroneous compressions. A certain **level** of **predictability** and innate predictive power is required for the successful **evolution** and **survival** of living things" (1991, p.43).

Of course, as noted by BARROWS our **brain** can perfectly produce these imaginary or erroneous compressions, as for example "see canals on Mars and all manner of exotic things lurking into inkblots". Thus, let us use **algorithms**, but let us also beware of them!

Cybernetic and systemic **concepts** offer however new tools for compression.

G. KLIR, for instance, proposes his **activity arrays** as compressed **behavior** generating devices, allowing eventual law-discovery **processes** (1975, p.167).

→ **Algorithmic incompressibility**

0577

COMPUTATION (Concepts of) ²⁾

According to Cl. EMMECHE there are two distinct concepts of **computation**. The first one is the representational concept, i.e. "... logical **operations** on **symbols** that can be defined purely **syntactically**, but which nevertheless signify specific numbers and mathematical **operations** (i.e. concepts with a **semantic** content by which we attempt to solve a specific mathematical problem...")

The second one is the physical, or non representational concept, i.e. "... **processes** that not only take place in a **trivial** sense in physical systems (or **models** of these) and are therefore

dependent on their **dynamics**, but which are essentially inherent in these **processes** and demand no further interpretation or adscription of **meaning**" (C. EMMECHE, 1994, p.127-8)

The first concept corresponds to any programmed **digital computer**. The second one would for example be related to the computational activity of **neurons** in the **brain**.

0578

COMPUTER: Analog or Digital;⁵⁾

Still (2004) most computers of common use are digital, i.e. based on **binary hardware** and translation of **data** into **binary codification**. They also are sequential, i.e. doing "one thing at one time and at one place in the arithmetic unit" (K. KRIPPENDORFF, 1986, p.14).

Analog computers on the contrary allow for direct **simulation** through the use of **continuous** physical and analogical **representation of data flows** by, for instance hydraulic or electrical **flows**. However, in KRIPPENDORFF's words, while "there is no restriction on the physical **processes** analog computers may utilize... compared with digital computers, (their) **programming** is time consuming and limited in scope" (p.3).

0579

COMPUTER (Connectionist)⁵⁾

A computer made of many simple computational units, able to do massive **parallel processing**.

The appearance of the **connection machines** and the development of **networks** introduced in recent years new possibilities leading to **distributed parallel processing** and to "machine intelligence" in a more extended sense.

M. BODEN writes: "Connectionist computation is not the manipulation of formal **symbols** by **programmed rules**. It is a **self-organizing process** of **equilibration**, governed by differential equations (which deal with statistical probabilities) and comparable to **energy** exchange in physics" (1990, p.124).

0580

COMPUTER in systems science^{1) - 3)}

G. KLIR states that the computer has "a dual role in **systems science**. In one of the roles it is a methodological tool for dealing with systems problems. In the other role, it serves as a laboratory for experimenting with systems. The purpose of this experimentation is to discover or validate laws of **systems science**". He adds the following important comment: "In contrast to laws of nature, laws of **systems science** characterize properties of various **categories** of systems rather than **categories** of real world objects".

Computers thus can help finding **homomorphisms** and **isomorphisms** between systems in a same **category** or between systems in different ones.

And "The aim of experimentation (with computers) is to discover useful properties characterizing the **category** of systems or, alternatively, to validate some conjectures regarding the **category**" (1993, p.38).

0581

COMPUTER MODELS^{1) - 3)}

G. KLIR states: "As a rule, genuine system problems are computationally extremely difficult. They are often made tractable by overly strong simplifying assumptions that are usually not explicitly stated. The resulting **methods** can then deal with sizeable systems emerging from practical application and produce "impressive" results, but the significance of these results is questionable at best. Such methodological dishonesty is contrary to the spirit of **systems science**. The latter is not interested in producing immediately marketable methodological tools at the cost of convenient simplifying assumptions whose validity is dubious, but rather in pursuing basic methodological research involving genuine systems problems" (1993, p.50).

KLIR proposes better uses of computers in systems science. (see above).

For D. MEADOWS and her collaborators different but not contradictory views, see Model (Computer)

0582

COMPUTERS: Serial and parallel⁵⁾

Already in 1957, J.von NEUMANN distinguished clearly sequential and parallel computers (at a time nobody had yet dreamed of **connection machines**). His **model** of a parallel "computer" was the **brain**. In his own words: "... the natural componentry favors **automata** with more, but slower, organs, while the artificial one favors the reverse arrangement of fewer, but faster, organs. Hence it is to be expected that an efficient organized large natural **automaton** (like the human nervous system) will tend to pick up as many logical (or informational) items as possible **simultaneously**, while an efficiently organized large artificial **automaton** (like a large modern computing machine) will be more likely to do things successively – one thing at a time, or at any rate not so many things at a time. That is, large and efficient natural **automata** are likely to be highly **parallel**, while large and efficient artificial **automata** will tend to be less so, and rather to be **serial**.

"... it should be noted, however, that **parallel** and **serial operation** are not unrestrictedly substitutable for each other... More specifically, not everything **serial** can be immediately **parallelized** – certain **operations** can only be per-

formed after certain others, and not **simultaneously** with them (i.e. they must use the results of the latter). In such a case, the **transition** from a **serial** scheme to a **parallel** one may be impossible, or it may be possible but only concurrently with a **change** in the logical approach and **organization** of the procedure. Conversely, the desire to **serialize** a **parallel** procedure may impose new requirements, since the results of the **operations** that are performed first must be stored while the **operations** that come after these are performed. Hence the logical approach and **structure** in natural **automata** may be expected to differ widely from those in artificial **automata**. Also, it is likely that the **memory** requirements of the latter will turn out to be systematically more severe than those of the former" (1958, p.50-52).

In effect, the **parallel automaton** – natural or artificial – does progressively construct **algorithms** through the application of a **set of rules** in its **network**, while the **serial**, i.e. sequential one is based on a previously introduced **deterministic algorithm**, which may of course be quite complex.

The treatment of complex **networks models** by sequential computers is inevitably distorted, as for example in the case of FORRESTER's **systems dynamics**.

R.W. FULLER and P. PUTNAM clarified still more this matter: "The **parallel** calculator functions to pick up **correlations**, to sift for and to isolate significant new **correlations**, while the series calculator is designed to help establish the consequences of **correlations** already well defined (Like NEWTON's laws)" (1967, p.99).

0583

CONATION²⁾³⁾

The aspect of mental **process**, or **behavior** directed toward **action** or **change**(Amer.Her. Dict., p. 276)

Conation derives from "conatus", latin word for attempt, effort, endeavor.

Conation behavior is related to impulses and desires, but translates these to **volition** and intentional action.

It seems to imply a **coordination** between different **levels** of the central **nervous system**.

→ **Behavior (Anticipatory)**

0584

CONCATENATION¹⁾²⁾

→ **Organization: a descriptive language**

0585

CONCENTRATION¹⁾⁴⁾⁵⁾

The gathering of a significant number of **elements** within a limited **space**.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

Concentration is a widespread **process** among animals and people. It obeys to a **variety** of causes, possibly the most basic is related to **thermodynamics** and **entropy production**. (Prigogine's theorem of **minimum entropy production** and his **model of structuration** through **dissipation of energy**)

Concentration may result from specific environmental pressure, as in the cases of the amoeba *Dictyostelium discoideum* or some species of locusts mutating to their gregarious **phase**.

In fishes and in birds, concentration leads to protective **herd effects** and in social insects it has similar but much more complex effects.

It seems that, in all cases of concentration, some specific factor of reciprocal **perception** is at work. In many animal species **pheromones** are such factors. Once reciprocal **perception** is activated, it tends to become self-maintaining, or even self-reinforcing. A very suggestive case is **stigmergy**, in termites societies where close contacts lead to positive **behavioral feedback** and introduce the possibility of constructive social **coordination**.

In fact, the gathering of elements, formerly unconnected and behaviorally independent, seems to be a condition for the **emergence** of systems of higher **levels of complexity**, in a kind of **self-organizing cybernetic process**. V. Csanyi described this transformation as **auto-genesis**.

The human species is of course by far the most self-concentrating species. Its "pheromone" is **language** and its **efficiency** is in the transmission of **information**. Human concentration has been accelerating all along history and the present growing megalopolis are the most outstanding example of this trend.

→ **Hexagonal space filling; Implosion; Node (critical); Stimulus; Threshold; Tropism; Zero-system**

0586

CONCEPT ³⁾ - 4)

The general **meaning** given to a word or a **set** of words

According to E. BUCHBERGER: "A concept is an ordering **representation** of what are considered to be the necessary and sufficient characteristics of a **set of objects**" (1987, p.77). An example is "dog" as a general term applied to numerous different animals, all of whom however share some common characteristics.

These definitions conceal tricky **semantic** problems, on different **levels**: psychological, social and cultural.

J.Z. YOUNG thus expresses the psychological one, defining the concept as: "The learned **program** for the use of a word or a **set of words**" (1978, p.291). The word "learned" conveys perfectly PIRANDELLO's quip according to which we "merely chew again the dialogue of

the dead ones" (in "Henry IV"). As to the social aspect, no concept has ever a **communication value** if not commonly accepted as such and **validated** by recurrent **consensus** through **conversation** "a la PASK".

The cultural aspect has been considered by M. MARUYAMA in his studies on "**mindscape**s" (1966, etc.). **Transcultural consensus** on concepts is even more difficult and insecure than the social **consensus** within a same culture. This could be called the "**semantic declination**", somehow analogous to the magnetic declination.

In any case, as stated by K. KRIPPENDORFF: "Concepts are neither true nor false, but more or less applicable (a) to recognize an **object** as an instance of the concept (**recognition**), (b) to produce or to understand sentences in which the concept is expressed and (c) to develop **constructs** or **cognitive systems** using the concept in question" (1986, p.14).

To round off, WITTGENSTEIN's pun: "Concept" is a vague concept" (as quoted by EDELMAN, 1992, chapter 10th' epigraph) is quite more than a pun.

0587

CONCEPT AND PERCEPT ³⁾

L.von BERTALANFFY called for the **interaction** and **integration** of percepts and concepts: "Analysis has to proceed at two **levels**: that of *phenomenology*, that is of direct experience, encompassing **perception** of outside things, feelings, thinking, willing, etc.; and of *conceptual constructs*, the reconstruction of direct experience in systems of **symbols**, culminating in science; it being well understood that there is no absolute gap between percept and concept, but that the two **levels** intergrade and interact" (1967, p.94).

Such **interaction** and **integration** is a permanent feature of human mind. However, it has not yet been generally recognized, due to the dominant tendency to reification.

Neither percept nor concept are "pure". Any concept is an ordered **abstraction** of former percepts, and any percept is "tainted" by formerly acquired concepts. It all must necessarily start in the newborn **brain**, through some basic **rules of neuronal nets operation**.

On this topic, J.W. SUTHERLAND even writes: "... simply because a concept developed ab intra (with no *apparent* empirical groundings) there is no guarantee that it will not be real - i.e., there is always a possibility that a congerie of man's mind might parallel a congerie of nature. Hence, the concept has the same a priori right to be considered by science as the percept" (1973, p.84).

0588

CONCEPT (Components of a) ³⁾

According to A. and H. DAMASIO: "Concepts are stored in the **brain** in the form of "dormant" records. When these records are reactivated, they can re-create the varied sensations and **actions** associated with a particular entity or **category** of entities. A coffee cup, for example, can evoke visual and tactile **representations** of its shape, color, texture and warmth, along with the smell and taste of the coffee or the **path** that the hand and the arm take to bring the cup from the table to the lips. All these **representations** are re-created in separate **brain** regions, but their reconstruction occurs fairly simultaneously" (1992, p.70).

This **understanding** of concepts retrieving (or constructions) is based on the **model** of interconnected **neural network** in the **brain**, including **mediation layers**, specially studied by these authors.

0589

CONCEPT (Context-dependent) ³⁾

M. KUBAT comments: "In the real world, concepts are usually not crisp but, rather, tend to change (more or less) their **meaning** with **context**" (1992, p.392).

L. THAYER explained this by the existence of what he called "**epistemic communities**", each with a specific **understanding** of every concept, obtained by a (progressively shifting) **consensus** (1972, p.112). In every **community**, **language** use is largely an **autopoietic process**.

According to W. FRITZ, who bases himself on his experiments with **artificial intelligent systems** (on a digital computer), experiences leading to positive or negative results are registered by the system and their comparison and **accumulation** derive in "actuation **rules**" (i.e. prescriptions about suitable **action** in specific **situations**), which are stored for possible subsequent use. These **rules** can undergo **reinforcements**, be transformed or forgotten. They are created on different **levels**: practical **motor habits** (for instance, riding a bicycle); practical **habits** with a neuro-mental **component** (driving a car); linguistic **habits**, etc... For FRITZ, the most abstract and general **rules** are those called **concepts**, because they are a multi-use synthesis of many experiments (pers. comm.).

These ideas are consonant with A. KORZYBSKI's **structural differential**, a general **model** of the way we extract **abstractions** at various **levels** from observed **events**.

0590

CONCEPT CROSSING ¹⁾ - ³⁾

"The combination of concepts from different **fields** of specialization" (M. MARUYAMA, 1985, p.387).

Concept crossing produces cross fertilization of ideas and techniques, and enhances **creativity**. By **analogy** with A. KOESTLER's concept of **bisociation**, it could be called "multisociation".

According to MARUYAMA, this technique should be associated with **design looping** and **experience looping**. In this way it becomes possible to evade from **lineal causal** stereotypes (1994, p.37).

0591

CONCEPTUAL BLOCKING ⁴⁾

K. BAILEY writes: "Conceptual blocking occurs when use of some vital **concept** is precluded within a **paradigm** by the use of some other concept which contradicts or prohibits its use. For example, PARSONS over reliance on the concept of **equilibrium** in his **social systems theory** precluded or blocked the effective analysis of social change in systems not characterized by equilibrium. That is, if the concept was said to be equilibrium, this was defined in such a way that **change** was minimized or short lived. Further, since only systems in equilibrium were emphasized, the analysis of change in other systems was neglected" (1996, p. 8)

As an example, PRIGOGINE's **model of dissipative structuration in systems far from equilibrium** seems to be a much more adequate conceptual **frame of references**.

For an **explanation** of the deep and accelerated evolution of our **man-planetary system** and associated **technosphere**.

→ **Blindsports; Entropy production (minimum); Methodological pluralism; Model building; Sociognosis; Sociosphere; Sociotechnical system**

0592

CONCEPTUAL MODEL ²⁾

A systemic account of a **human activity system**, built on the basis of that system's **root definition**, usually in the form of a structured **set** of verbs in the imperative mood" (R. RODRIGUEZ ULLOA, Glossary, 1999)

"Such models should contain the minimum necessary **activities** for the system to be the one named in the **root definition**. Only **activities** which could be directly carried out should be included - thus admonishments such as "succeed" must be avoided

"Conceptual models may be validated or justified only in terms of logic, not be **mapping** on to the real world, since they do not purport to describe the real world. They may however be compared with the **formal system model** in order to check that they are not fundamentally deficient" (Ibid).

→ **Truth**

0593

CONCEPTUAL SITUATION ³⁾

The mind **state** of the user of a **language**, "i.e. a **structure** made up of certain items and certain **relations**" (after. E.von GLASERSFELD, 1988, p.6).

The conceptual situation exists "regardless of whether the **structure** could be said to have originated in **perception**, in imagination, or even as an illusion".

In effect, the linguistic expression will be identical whether it describes a phantasy, a hallucination, or what is called observable reality" (Ibid).

Any possible differentiation could emerge only if the speaker has a clear **semantic understanding** of his/her own conceptual condition, quite a difficult achievement.

→ **"Semantics (General)"**.

0594

CONCEPTUAL SPACE ^{3) - 4)}

The **domain** open to search, research and creation as delimited by existing mental **constraints**.

This notion, developed by M. BODEN in her inquiry in natural and **artificial intelligence**, is closely related to the **paradigm** concept. To any conceptual space corresponds a system of **generative rules** (or a generative system) that defines the possible research **space**. In M. BODEN's terms, it is a kind of "**map** ... used to generate an indefinite number of very useful "coulds" and "cannots" (1990, p.47).

(BODEN's **generative rules** seem to be very close to FRITZ' **actuation rules**).

Or: "... a conceptual space (or a family of neighbouring conceptual spaces), whose potential is both created and limited by the **constraints** concerned" (p.158).

In a conceptual space, **congruences** are established in accordance with the ordering **constraints**.

Should the **generative** system be modified, the conceptual space would be to. This happens for example when one emigrates into another culture, or start to work in a different discipline. M. BODEN states: "The deeper the **change** in the **generative** system, the more different - and less immediately intelligible - is the corresponding conceptual space" (p.81).

The conceptual space is progressively acquired through **learning** and ends up with a kind of **autopoietic** mental **closure**, which however implies the previous internalization of simpler **competences** and **maps**, i.e. ordering **constraints**. In M. BODEN's words: "These **representations** arise on several successive **levels**, each time enabling the person to exploit the prior **knowledge** in ways that were not

possible before. The person progresses from one skill that is fluent but *automatic* (being varied only with much effort and little success) to one that can be altered in many ways" (p.64).

The subject is closely related to the "**creativity**" one.

0595

CONDENSATION ²⁾

The reduction of **redundancy** in a **message**.

As some **messages** are very **redundant**, condensation may be quite useful for an optimal use of the **channel** as well as for the **decoder's** job.

However, a total elimination of any **redundancy** is dangerous, because the slightest **noise** in the **channel** would impair the **understanding** of the **message** for the **receiver**.

According to R. ACKOFF and F. EMERY, condensation may either "reduce the receiving **time** required" (using a *digest* of the **message**), or "provide a brief **description** of its **content**" (using an *abstract*).

A third way seems sometimes available, somehow equivalent to the second one, at least for suitably organized or trained systems: use one brief conventional **sign** or **symbol** representative of the whole **message**. Roads signposts are **symbols** of this kind.

0596

CONDITIONAL PROBABILITIES MATRIX ²⁾

"A matrix determining the relative probabilities of various **patterns** (and **patterns** of **patterns**) of **behavior** in all possible circumstances" (1969, p.95).

Mac KAY expresses this also in the following alternative way: "A **hierarchic structure** of organizing "sub-routines" to determine these conditional probabilities interlocked in such a way as to represent implicitly the **structure** of the **environment** (the world of **activity**) with which the **organism** must **interact**. For many **purposes**, we may reduce it to the filling-out of a world-map, ready to be consulted according to current needs and **goals**" (Ibid).

These very interesting definitions evoke:

1 - K. STEINBUCH's "**Learn-matrixes**" through which a system is establishing **connections** between specific **signs** and specific **meanings**.

2 - H. MATURANA and F. VARELA "**organizational closure**" according to which everything which happens to a system happens within the system and then only within the **limits** of the predefined **capacity** of **autopoiesis** (**self-reproduction**) of the system. (Remains to explain wherefrom this **capacity** comes into being and why and how it becomes closed).

3 - W.R. ASHBY's "Law of **requisite variety**" and **concept** of **constraint**.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

4 – the incapacity for any system to construct a complete and totally trustworthy **map** of the world wherein it exists; as shown by A. KORZYBSKI (1933, 1950).

0597

CONDITIONED REFLEX→ **Reflex (Conditioned)**

0598

CONDITIONS (Initial)^{1) – 2)}

The **state** of a system at the beginning of its **activity**, or when an **observer** starts to observe it.

Authors like M. MARUYAMA, H. von FOERSTER and others insist on the importance of initial conditions as determinants of the nature of a system a-building.

The first one is the **substrate** or **environmental** conditions. No system is constructed in a void. Even in abstract **models** like in Go, in CONWAY's **Games of life** or in MARUYAMA's **deviation-amplification processes**, the **substrate** is a grid with specified properties, as for example, being formed of adjacent squares and having (or no) spatial **limits** in two or more **dimensions**.

For **living systems**, the initial conditions are clearly defined in each case by biological **constraints**, which are absolutely unavoidable.

Another initial condition is the **homogeneous** or **heterogeneous** nature of the original **elements**, which is paramount for their future ways of **interaction**. (**Clustering**, **symbiosis**, **organizational closure**, etc...).

A third one is their reciprocal **localization**, whose importance is visible in Go, in chess, or in CONWAY's games, and now also better known in embryogenesis, where they are paramount for an ordered **development** of the **living system**.

Finally, the question of the **interaction rules** is somewhat puzzling. Whereas introduced or potentially inscribed somewhere in the initial **situation**, they are undoubtedly themselves a most important initial condition: Different **development rules** will necessarily produce different systems, even if all other conditions are identical.

For the importance of **sensitivity to initial conditions** for the onset of **deterministic chaos**, see "Sensitivity to ..."

→ **Zero System**

0599

CONFIGURATION³⁾

"Any **phenomenon** that can be distinguished" (F. HEYLIGHEN, 1992, p.4).

According to HEYLIGHEN, the concept includes "anything that is called feature, property, **state**, **pattern**, **structure** or **system**" (Ibid).

"Configuration" implies at least the notion of some kind of *non random* arrangement of **elements**.

HEYLIGHEN adds the following: "The selective retention of a stable configuration depends essentially on two factors: the configuration must be intrinsically **stable** (internal **selection**), and able to resist **changes** in its **environment** (external **selection**)" (pers.comm.).

G. BROEKSTRA considers configuration: "... as a **holistic structural** manifestation of the interplay of the underlying **processes**" (1993, p.76).

0600

CONFIGURATION (Initial)^{2) – 5)}

The original ordering of the first **elements** of a **cellular automaton**.

P. GREUSSAY comments about the **dynamics** of the **automaton**: "The **set** of the **states** of the **cells** is the 'genetic material' of the initial configuration... **Self reproduction** is actively directed by the initial configuration itself, though a **transitions function**" (1988, p.1322).

This **function** depends on a **transition rule** or **set of rules**, as for example in MARUYAMA's **deviation amplification mutual causal processes** or in J. CONWAY's **games of life**.

0601

CONFIGURATOR²⁾

"A special **model** of the **object**, exercising the methodological function of **synthesis**" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.123).

According to these authors: "This **model** has to be evolved in such a way as to coordinate different notions of the **object** and explain each of them as a particular "cross-section" or angle from which the **object** is viewed. Of special significance is the fact that the researcher, using the configurator **model** for presenting the **object** as a system, has to start out from the idea of the systemic **structure** of the given **object**."

"The initial notion is of a hypothetical character and is more precise in the course of further theoretical treatment of the **object**" (Ibid).

0602

CONFIRMATION³⁾

1. A result of **perception** of **redundancy** in a **message** registered by a **receiver**.

Confirmation may act as an **operator** and lead to **reinforcement**.

2. "The support given to a hypothesis or **model** (a) by evidence available in the form of **data** or **observations** or (b) by logical deduction from premises, ultimately from the axioms of a formal system" (K. KRIPPENDORFF, 1986, p.15).

This could be considered a near synonym of "**validation**"

0603

CONFLICT: Some proposed systemic views⁴⁾

Conflict is for human systems, **competition** led to extremes. K. KRIPPENDORFF defines conflict as: "A state of affairs in which two or more parties claim possession of something not all can have simultaneously" (1986, p.16).

Conflict seems to be a normal result of the presence of two or various systems vying for the same **resources**, particularly when these are scarce. While it may lead to the destruction of one of the antagonists, it generally ends through a **process** of reciprocal **adaptation** through the establishment of some **regulating mechanism**, which of course has to be paid for and must thus be **cost-effective** if it is to persist. The repetition of such **processes** at different **levels** leads to the apparition of a stratified **hierarchy** of **regulators**, a **phenomenon** quite apparent in any **complex system**.

Conflict may appear anew if some modification in the **environment** turns out to be favorable to some of the competing systems and unfavorable for others.

Conflict also presents an **evolutive** aspect.

When some modification intervenes in the nature or **behavior** of a system, as interacting **part** of a **suprasystem**, new reciprocal **adjustments** become generally unavoidable as a result of the propagating impact. This, frequently results in new conflicts, which in turn lead to new **processes** of reciprocal **adaptation**.

Conflict can also appear between **percepts**, **concepts**, **models**, etc... constructed by different **observers**.

R. ROSEN states: "In each specific case, it appeared that the roots of the conflict lay not so much in any particular objective **situation**, but rather in the fact that different **models** of that **situation** had been adopted by the different parties in the conflict. Consequently, different **predictions** about that **situation** were made by these parties, and incompatible courses of **action** adopted thereby. Therefore, a general theory of policy making (or, as I would argue, a general theory of **modelling**) would have as a corollary a theory of conflict and I hoped of conflict resolution" (1991c, p.543).

This has also been expressed by J. WARFIELD as the

Law of inherent conflict

"No matter what the complex issue, and no matter what the **group** involved in its study, there will be significant inherent conflict within the **group** stemming from different **perceptions** of the relative significance of the factors involved in the complex issue" (1991, p.200).

WARFIELD even states that in most cases, all participants will be wrong in some sense. The

roots of this situation are in **cognitive** and emotional differences. It could also be related to differences in **mindscapes**, in MARUYAMA's sense.

The real systemic problem with conflict is thus: How can we convince people (even honest ones, not to speak of the others!) to discuss in a critical way their own **viewpoint**, to try to reach **consensus** and to negotiate more or less satisfactory solutions. It is really a problem in applied social **methodology**.

More recently the conflict solving problem has been tackled by the Austrian sociologist G. SCHWARZ (1999)

This author proposes a **process** of conflict solving that takes in account the generally observed conflict **situations**.

- 1- escape: "run away"
- 2- destruction: "kill your opponent"
- 3- submission: "subordinate your opponent"
- 4- delegation: an independent authority (judge) decides the solution
- 5- compromise: an arrangement between the two positions
- 6- consense: seeking for a dialectical synthesis

According to Schwarz these six levels form a kind of order or **learning process**. Of course the learning can be cut short at any of the three first stages. If not, the process can take place

- a) as a progress in an inter-individual conflict
- b) as a progress in the **consciousness** of conflicts in a person or **organization**
- c) as a progress of the social abilities of mankind as a whole to manage conflicts

(As quoted from G. OSSIMITZ, 2000, p. 2)

0604

CONFLUENT²⁾

The collecting point, area or volume of a number of **lines of behavior**.

This is the name W.R. ASHBY gave to what is now generally known as an **attractor** (1960, p.185). Each confluent corresponds either to a **state of equilibrium** or to a closed **cycle** of specific **states** (in topological terminology a **vicinity**, or a **basin**).

According to St. BEER, a confluent is structured by a **set** of lines of **entropic drift** (1968, p.476).

In **homeostatic** systems, any **process** tends to return to its proper confluent until ejected from its **basin** by some very strong **disturbance**.

0605

CONFORMATION¹⁾

→ **Organization: a descriptive language**

0606

CONGERIES²⁾

A reunion. of uncoordinated **elements**.

This (plural) term generally used as a singular, is an infrequent synonym for "**aggregate**".

0607

CONGLOMERATE¹⁾²⁾

A non-ordered **collection** of **elements**.

The elements can be of the same kind or different ones, and do not exhibit a common **autonomous behavior** or **synergy**.

In some cases the conglomerate may however show a tendency toward **organization**, possibly under changing environmental conditions.

→ **Cluster; Congeries; School; Shoal; Stigmergy; Swarm; Zero-system**

0608

CONGRUENCE (Structural)^{3) - 4)}

1 The basic and limitative **organization** of our capacity as an **observer** and actor.

2- The basic and limitative **organization** of the global capacity as **observers** of some **group** of individuals (probably in social animals, as well as in humans).

The first **level** of structural congruence refers to the individual and has the following roots:

a) it results from the progressive **learning**, which is slightly or vastly different from one individual to another, and organizes a specific **conceptual space** on the basis of defined **constraints**, for each of us (for example, the **rules** of harmony for an 18th Century composer).

Apart from basic physiological limitations to **perception**, **learning** differentiates and refines some perceptive abilities, while it stifles others. The mind ends up with a kind of general congruence of **autopoietic** character and a great number of more specific congruences (for example between the specific techniques in a profession, or driving a car).

b) individual **learning** reflects of course collective **mindscapes**, which frame it and orient it toward specific capabilities and **inhibitions**, defined by the culture. The second **level** of structural congruence is a result and also the basis of **communication**. It is constantly reconstructed by a **process** of shifting **consensus** and becomes reflected for example in **semantic polysemy** and the slow **evolution** of natural **languages**.

0609

CONJUNCTION^{1) - 2)}

The joining of **elements** to constitute a system.

This term has been introduced by A. BOGDANOV as early as 1922. It is still generally ignored and unused.

This is curious, since the reunion of **elements** that start to interact is obviously the foundational act of any system.

0610

CONNECTANCE^{2) - 4)}

"A measure of system **connectedness** based upon the mean number of nonzero **interaction** terms per **compartment** of the system under consideration" (T.F.S. ALLEN & T.B. STARR, 1982, p.264).

This definition should be completed by the following comment of W.D. GROSSMANN and K.E.F. WATT in reference to the evermore intense **interactions** of all types between human individuals and **groups**: "Excessively intense or frequent causal **connections** between systems or systems **subcomponents** can foster rapid **propagation** of shock **waves**, or internal **perturbations** within systems. At present nobody can tell to what degree **connectivity** is tolerable on a global scale...

"What are the preconditions for avoiding the present high degree of **interactions** becoming threatening?" (1992, p.9).

This clearly systemic problem, that also can be observed in animal **populations**, has been formerly studied by J.B. CALHOUN from the slightly different angle of the relation between **population density** and social pathology by **overcrowding** (1962 and 1971).

→ "**Connectivity**", a near synonym.

0611

CONNECTANCE²⁾

The percentages of **links**, between the **elements** in a **network**.

The concept also appeared recently in **ecology** (A. FLOOD, 2001, p. 30-33). N. MARTINEZ introduced the "constant-connectance hypothesis according to which "a particular balance of food-**web complexity** exists in nature...- between everything eating everything, and everything not eating everything, and everything eating nothing (see R. WILLIAMS and N. MARTINEZ, 2000) "

Connectance is related to the global **stability** or **instability** of the network and is thus characteristic of its **emerging complexity**.

FLOOD comments: "**Distributions** of species, the World Wide Web and metabolic networks all seem to show robust **self-organization phenomena**. It is the global features of such **webs** that matter, not the individual characteristics of the units that make them up"(p. 33)

In **ecological networks** "a species (may go) extinct because of the removal of a closely connected neighbour"(ibid.)

This can be obviously happen in economic and in social networks.

→ **Graphs; Power laws; Small world**

0612

CONNECTED COMPONENT²⁾

"A component of a system which is involved in at least one of the main lines of **communication** of the system" (T.F.H. ALLEN & T.B. STARR, 1982, p.264).

0613

CONNECTEDNESS²⁾

The degree of interconnexion of an **element** with other ones in a **network**.

"A general term for the cohesiveness of a system" (T.F.H. ALLEN & T.B. STARR, 1982, p.264).

ALLEN and STARR comment: "Systems with strong **interaction** terms are relatively highly connected, as are systems with a large number of the **parts** interconnected (as measured by connectivity and connectance)" (Ibid).

0614

CONNECTEDNESS (Degree of)^{1) - 2)}

ASHBY discussed the connectedness among **elements** within **complex systems**. He insisted that such **systems** are neither fully connected, nor totally unconnected.

He wrote: "The separation into many **parts** and the union into a single **whole** are simply the two extremes on the **scale** of "degree of connectedness". He added: "**Adaptation** ... demands not only the **integration** of related **activities** but the **independence** of unrelated **activities**" (1960, p.157).

Moreover, the degree of connectedness may vary in different **subsystems** and also with **time**.

Strong or weak connectedness corresponds to the **richly or poorly joined systems** or **environments**, in the somewhat peculiar vocabulary of ASHBY.

Finally, the degree of connectedness defines the system's **constraints**.

0615

CONNECTEDNESS (Excess of)^{1) - 2) - 4)}

A system is basically a **set** of interconnected **elements**.

However, the degree of connectedness varies widely according to the type of systems. While a **composite system** is very weakly connected, differentiation in more **complex systems** is related to selective **connections** between **parts** or **elements**, which define global and local **functions**. It can be closely related to **heterogeneity** obtained by **constraints**.

A totally connected system should be absolutely determined and thus completely unable to adapt itself to new **situations**.

According to ASHBY "...for the **accumulation** of **adaptations** to be possible, the system must not be fully **joined** (i.e. connected)... certain **parts** should not communicate to, or have an

effect on certain other **parts**". Hence, ASHBY points out that "The **Homeostat**...is too well integrated, cannot accumulate **adaptations**" and "...it must not be overlooked that **adaptation** may demand **independence** (of the **parts**) as well as **interaction**" and yet...

"...by developing partial, fluctuating and temporary **independencies** within the **whole**,... the **whole** becomes an assembly of **subsystems**, within which **communication** is rich and between which it is more restricted" (1960, p.255-257).

Good examples are the different **organs** within a **living system** or the distinct sections within an enterprise.

0616

CONNECTION^{1) - 2)}

A more or less permanent or repetitive **interrelation** between two or more **elements**.

Connections are of many different kinds. See: "**Connections (a classification of)**" and "**connection modes**"

Any connection implies the propagation of some **flow** from one **element** to the other(s). The **flows** may be of **matter**, **energy** or **information**, inasmuch as it is possible to distinguish them.

The **interrelation** is either one-way, or reciprocal.

Connections in a system can generally be represented through **graphs** or **matrixes**. This is more easy for **ergodic systems**, after a statistical study of the succession of **states**.

W. PAULI observed long ago (1954) that the use in physics of "statistical laws of nature with primary **probabilities**" shows a tendency to amplify the older more narrow idea of "**causality (determinism)**" to a more general form of "connections" in nature (1954, p. 301)

Indeed it has been seen more recently that connections may be inscribed in **self-organized criticality**, in **fractals** and in **chaotic interrelations**

0617

CONNECTION MACHINE⁵⁾

A massively **parallel** computer.

The connection machine has been conceived by D. HILLIS and deeply differs from the common **parallel computers**, which are practically working as a bundle of multi-**sequential** machines.

HILLIS' machine is a **network** of numerous individual **binary processors**, whose **interconnections** are organized within a complex multi-dimensional **net**. (see "**hypercube architecture**").

J. BRIGGS and F.D. PEAT write: "According to connectionists... computer **programs** should not be **sets** of logical instructions aiming at producing predictable results; they should, on

the contrary, be simply instructions aimed at varying the weights of connections among **processors**, leading in this way the machine to construct **nonlinear networks**" (1991, p.174).

0618

CONNECTION MODES²⁾

Connections among **elements** can be arranged in a number of different ways:

On line: The **elements** are connected in such a way that each one is linked only with its antecedent and its successor on a line. This is a very limited and restrictive way to connect **elements**.

Ring: The **elements** are still connected on line, but the last one is again connected with the first one as its successor. Rings may allow for **feed-back**, for **catalysis**, for **organizational closure** and for **hypercycles**.

Tree: The **elements** are arranged in such a way that each one becomes a **node** with one connection upstream and one, two, or generally more downstream. **Hierarchies** can be represented by trees.

Crossbar: In this arrangement, every **element** is connected to every other one. However, the number of connections grows as the square of the number of **elements**. Without **constraints**, **structures** of this kind become clogged and generally undefined for any specific use.

Three or more dimensional structures: as for example cubic or **hypercubic nets**. This mode of connection allows for **constraints** by trade-offs between the number of direct connections permitted to each **element** and the minimum and maximum length of the **communication** line between two **elements** not directly connected. Every **structure** of this type is a **net**.

Nets of nets: Such three or more dimensional **nets** can be interconnected. This **mode** allows for many local **nets** to become integrated within a global one, while maintaining some **autonomy** and **specialization**. **Brains**, **connection machines** and societies are probably amenable to be thus modelled.

0619

CONNECTION (System forming)¹⁾

A type of connection specific to organized **wholes**.

I. BLAUBERG, V. SADOVSKY and E. YUDIN speak of "organic" **wholes**, which seems unduly restrictive. (1977, p.145).

Connections are essential in systems: no unconnected number of **elements** can ever be considered a system. Even **composite systems** are weakly connected, through the general conditions to which they are submitted.

On the other hand, isolated or temporary connections are not significant, from the systems point of view. Systems are multi-connected and, moreover, generally made of interconnected **subsystems**, themselves made of connected **components**.

However, connections are selectively restricted and organized within the system, whose internal **constraints** give it a specific identity and functionality.

In systems, connections form **networks**, generally at different **levels**. Each system has its characteristic **networks**. Individual connections cannot be well understood if considered independently from the **networks**. This is why G. WEINBERG proposes a "Strong Connection Law" (1975, p.158), in order to do away with some principles of **reductionist** scientific **methodology** that cannot be applied to the study of systems, as for example:

- "Clear logical thinking requires that we vary only one factor at a time" (In a system, varying one factor triggers a chain **reaction** in the connective **network**)
- "All other things being equal..." (Systems are dynamic: nothing ever remains equal).

0620

CONNECTIONISM^{1) - 5)}

Parallel distributed computing within interconnected **nets**.

A system also can be understood as a **net** of simple **components** with **propagation** of **flows**.

E. ANDREEWSKY explains: "According to Connectionism, the **brain** and its neurons explain **behavior**, and the terms used in this field, such as neurons, synapses, **activation**, **propagation**, suggest a biological explanation for cognitive **phenomena**. The former **A.I.** abstract symbolic **representations** become a **set** of very simple **elements (formal neurons)** functioning in **parallel**. Like the **perceptron**, connectionist systems work through **learning**... Connectionist systems do not have central units, and each of their **elements** functions in its local **environment** in order to determine a **global cooperation**, that is the system's **organization**. The **network** shapes itself progressively with the **stimuli** it receives; in other words, its **learning activity**, which is continuous during its implementation, results in **changes of the network itself** (whereas classically, **learning** is only **change in knowledge representation**)" (1993, p.192-193).

Of course "**change in knowledge representation**" implies the previous existence of **knowledge**. Thus such a view of **learning** does not explain the genesis, or better, the **autogenesis of knowledge**.

The physio-psychological version of connectionism is an extension of D. RUMELHART, J. MCCLELLAND and G. HINTON's **Parallel Distributed Processing**, which is a **model** for **information processing**.

As to the **mechanism** of connectionist construction, E. ANDREEWSKY resumes J. MCCLELLAND and D. RUMELHART explanations: "The **communication** between the different units of this system no longer takes place by means of **messages** as in classical **Artificial Intelligence**, but through **activation values**: numbers and not **symbols**. The interpretation of the **operation** is no longer obtained in terms of **messages** transmitted between **modules** of the system; it represents the activated **states of the whole system**" (p.193).

Moreover, and in accordance with D. HEBB's **reinforcement** through repeated **stimulation**, connectionism implies **reinforcement** of pathways by frequent use.

Connectionism is also obviously and closely related to the more general problem of **auto-genesis in living** and in **social systems**.

Connectionist network: "A **parallel-processing** system made of many simple computational units, linked (as **brain-cells** are) by excitatory or inhibitory **connections**" (M. BODEN, 1990, p.124).

This author explains: "One unit modifies another's **activity** to different degrees, dependent on the relevant connection-weight (expressed as a number between plus-one and minus-one). The details of these weight **changes** are governed by differential equations, like those used in physics. A concept is represented as a stable **activity-pattern** across the entire system".

"In **networks** that can learn, the connection weights are continually adjusted to maximize the probability of reaching **equilibrium**. Connections used often are strengthened, and if two units are activated simultaneously, then connection weights are adjusted to make this more likely in the future" (Ibid).

Moreover: "The larger the **network**, and the more distinct the **patterns**, the more **associations** can be learnt" (Ibid).

→ **Algorithm (Back propagation)**

0621

CONNECTIONS (A Classification of)^{1) - 2)}

I. BLAUBERG, V. SADOVSKY and E. YUDIN propose the following classification of the different types of connections in systems:

"1. **Interaction** connections, further subdivided into connections of **properties** (these are registered, e.g. in the physical formulas of the type $p_v = \text{const}$) and connections of **objects** (e.g. humoral connections, connections of the predator-prey type in biology, connections between separate neurons in neuron-psychic processes).

A special type of **interaction** connections are those between separate subjects-individuals, and between human collectives or social systems...

...Within this type one may distinguish co-operative and conflicting connections

2. Connections of **generation**, or genetic ones, in which one **object** appears as the **agent** causing the existence of another one...

3. **Transformation** connections, further subdivided into:

a) transformation connections realized through a certain **object** which conditions this **transformation** or sharply intensifies it (such is the function of chemical catalysts).

b) **transformation** connections realized through direct **interaction** of two or more **objects**, in (and due to) which the **objects**, singly or jointly pass from one **state** to another (such is for example, the **interaction of organism and environment** in the **process** of forming the species).

4. Connections of **structure** (frequently called structural connections). Their nature is illustrated clearly enough by chemical bonds.

5. Connections of **functioning**... the common feature of these types is that **objects** unified by a connection of functioning jointly perform a definite **function**.

6. Connections of **development** which may be regarded... as a modification of functional **state** connections, the difference lying in that the **process of development** is essentially distinct from a simple change of **states** and therefore requires additional characteristics.

7. Connections of **control**, which, depending on their concrete type, may form a **variety** of either functional connections or of those of development" (1977, p.142-144).

As any classification in general, this one is tentative and could be ordered differently as, in the authors words it "exhibits an extreme diversity of **meanings** given to the "connection" **concept**" (p. 144).

A comparison with **connection modes** shows that, even in structural connections only, the diversity is significative.

Moreover any connection implies in principle an **interaction**, thus the first class includes the other six ones, even if the structural connections may in some cases appear to be a "fossilized" residue: petrified wood is an interesting example.

0622

CONNECTIONS RIGIDITY^{1) - 2)}

Many **complex systems** are characterized by "rigidly fixed connections between all their **links**, the presence or **function** of each of which is a sine qua non of the functioning of the whole system" (I.V. BLAUBERG, V. SADOVSKY & E.G. YUDIN, 1977, p.216).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The authors give the following example: "The central nervous system, the blood circulation system, the digestive system, the excretory system, etc., are rigidly connected and complement each other in our **organism**. Each of them is necessary and cannot be replaced by another. **Structures** of this type can greatly increase the **level of organization** of systems as compared to the **organization** of the individual **links** constituting them. But at the same time these systems are much less flexible and capable of restructuring than "**corpuscular**" systems" (Ibid).

The "corpuscular" system concept has been proposed by A. MALINOWSKY (see BLAUBERG et al, Bibliography) and is somewhat akin to the **composite system** introduced in this encyclopedia.

0623

CONNECTIVE SYSTEM^{1) - 2)}

A system made of an important number of simple interconnected units ("neurons").

Each unit receives an excitatory or inhibitory **activity** (or both) which, when reaching some **threshold**, produces a change of **state**. (after J. HORGAN, 1993, p.370).

We should be careful in the use of our vocabulary. Multiple electronic interconnections are most probably not exactly equivalent to biological neurons, if only for the inexistence of biochemical **processes of transmission of flows** in the case of so-called electronic "neurons".

Another important aspect is the highly **parallelism** in such a system: numerous local **activities** occur simultaneously in different zones of the system without producing instantaneously global **interactions** in the **net**. Any excitation or inhibition get transmitted with some **delay**, even if very short.

The global **behavior** of such a system is deterministic in a general sense, but it perfectly admits **simultaneous** and more or less **aleatory behavior**, locally, within the **limits** of the **determinism of the whole**.

Besides, such a type of **net** can show a considerable **endogenous activity**, but must necessarily receive **stimuli** from its **environment**. Moreover its activity probably make sense only if it results in some **action** on this same **environment**.

0624

CONNECTIVITY^{1) - 2)}

1. "A measure of the degree of connectedness of a system" (W.R. ASHBY & M.R. GARDNER, 1970, in ASHBY, 1981, p.85-87).

This definition is very close to T.F.H. ALLEN and T.B. STARR's definition of **connectance**.

ALLEN and STARR state that "connectance": "... is usually expressed as a percentage: the percentage of nonzero **interaction** terms as a percentage of all possible **interaction** terms, reasonable or otherwise, between the **components** of a system" (1982, p.264).

Systemics, as a **transdisciplinary methodology** of **models**, offers a high degree of connectivity, allowing for example for satisfactory links of biology and psychology within social theory (P. HEJL, 1985, p.112).

2. The global character of a **network** or system whose **elements** are interrelated to some defined degree.

Composite systems have a very low degree of connectivity - which anyhow is sufficient to subsume some collective and more or less **periodical behavior**, as for example **avalanches**. However, strong **integration** is the result of a higher degree of connectivity.

ASHBY expressed the idea that a system should have a minimum of connectivity (i.e. must be more or less "joined") if it is to perform some definite **functions**. However, an excess of connectivity (in too "strongly joined" systems) leads to behavioral **rigidity** and loss of **adaptiveness**.

St. KAUFFMAN distinguishes "solid", "liquid" or "gaseous" **phases** in **networks**, corresponding to the more or less numerous presence of what he calls "**frozen cores**". (1992, p.67). This can be considered as equivalent to a measure of connectivity.

Connectivity can be easily modeled by **graphs**, which may represent local connectivities of some **elements** and more global ones between these local **clusters**. It is a fine way to obtain a visual understanding of a **network**. (see for instance S. KAUFFMAN, 1993, p.420 and 490). This author also study the "connectivity properties of random graphs (which) exhibit **phase transitions**" (p.307-10).

3. In the formal **model** of a system, the property which makes possible for the **effects** to be transmitted throughout the system (R. RODRIGUEZ ULLOA, 1994, p.136)

The author states: "Connectivity can be physical as for ex. in a system of order and delivery processing, or be an **information flow** (verbal), or a flow of **energy** or influences (Ibid).

0625

CONNECTOR²⁾

Any active **element** in a **network**.

Any connector normally receives and transmits **messages** (through a great **variety** of means, according to the type of **network**).

It may also be able to store **information** and to load the **messages** it transmits.

In very dense **networks**, many connectors are redundant, which allows in case of necessity for their functional substitution if they are eliminated, at least up to some limit.

In **languages**, connectors are "**signs** that combine (or separate) the meaning of two or more **signs**" (R.L. ACKOFF & F.E. EMERY, 1972, p.175). Examples are the words "and, or, plus, minus" or their mathematical equivalents.

→ **Communication; Small world**

0626

CONNEXITY²⁾

"The **relation** of two **parts** without the mediation of a third **part**. Non-connectivity is the absence of this **relation**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.32).

These authors give the following example: "... the skin and seeds of an apple are non-connected. (On the contrary) three grains of sand (directly in contact) are connected (Ibid).

Connexity supposes thus the contact, *but not necessarily any interaction*.

0627

CONNOTATION¹⁾³⁾

→ **Denotation (Objective) and Connotation**

0628

CONSCIOUSNESS^{3) - 4)}

The state of a **living system** who perceives (is aware of) his/her own inside **knowledge** of inside or outside **phenomena** and possesses the ability to formulate it for him/herself and for **communication** with others.

Many definitions have been given of consciousness, probably because the subject is so difficult to grasp. The given definition has no pretense to be the only possible, nor even to be a very satisfactory one. In any case, it implies the existence of an internal microcosm, reflecting the external macrocosm and the **perception** of the difference between both.

R. FISCHER describe consciousness as "... narrative self-awareness" (1992, p.230).

G. PASK has been quite more specific: "A **process** is potentially conscious if it is organizationally closed, informationally open, and if **information** is transferred across **distinctions** that are computed as required to permit the execution of the **process**" (1979, p.214).

E. SCHWARZ indicates the three following attributes of consciousness:

"1. Existence manifested and felt in **space** and **time** through the **dialogue** between the **object** (the actual status of the system) and the **image** of this status in the (conscious being);

"2. **Self-knowledge**, as outcome of the **self-referential dialogue**;

"3. **Autogenesis**: self-production of its own **rules**, which means increase of **autonomy**" (1992, p.763).

This last point is very close to P. VENDRYES **concept of autonomy**.

B. RUSSELL gave of consciousness the curious following **description**: "The belief that makes us feel that the **image** is a **sign** of something else than itself" (1926, as quoted by J.P. CHANGEUX, 1992, p.709).

Consciousness seems however to depend basically of the capacity of **self-description**. H. MATURANA (as quoted by R. FISCHER) states: "... if an **organism** can generate a communicable **description** of its **interactions** and interact with the communicable **description**, the **process** can, in principle, be carried out in a potentially infinite recursive manner, and the **organism** becomes an **observer**. It can describe its **interactions** and communicate its **description** to others or to itself, and through the very same **process** it can describe itself describing itself" (MATURANA, 1979, in R. FISCHER, 1976, p.32).

H. Harry KLOPF writes: "Consciousness involves an awareness of self and is therefore an **emerging** property of **brains**, a property that is acquired as experience and **learning** provide increasing **information** with which to define the self, the **environment** and their **relationship**. In accordance with this definition, newborn infants are conscious only to a slight degree, if at all. (We can speak of degrees of consciousness just as we can speak of degrees of clarity of definition of the self and the **environment**, etc.)."

The author makes another important observation: "There has been a tendency in the past to confuse responsiveness in **living systems** with consciousness" (1972, p.37).

I. ALEKSANDER in turn states: "Consciousness is very heavily dependent on having a **learning** system that can represent the world more or less as it is. **A.I.** has always tried to do the **representation** at a **symbolic level** – so it has lost mental imagery, which seems to me to be the crux of consciousness" (Quoted by C. DAVIDSON, 1993, p.25).

K. BAUSCH speaks of consciousness as "embodied **awareness**". This implies that awareness can (but won't in all cases) **trigger** some **behavior**. This depends on the already constructed **frames of references**. In human beings, these include existing rational evaluations, but also **values** and **norms**, which do not necessarily have a rational foundation.

The effects of quite variable **levels** of consciousness in many different individuals and their resulting more or less coordinated and conscious **action**, is quite a difficult subject.

There seems to be now a growing **consensus** that consciousness is a complex emergent **process** in man, that results of the progressive **resonance** or **synchronization** between the thalamus and different **parts** of the **cerebral cortex** (A. CLERREMANS, 2000, p.83).

→ **Brain; Evolutionary and planetary consciousness**

0629

CONSCIOUSNESS (Economy in) ³⁾

G. BATESON observes that "... it is not conceivably possible for any system to be totally conscious" and "... every next step in the approach to total consciousness will involve a great increase in the (**brain**) circuitry required. It follows that all **organisms** must be content with rather little consciousness and that if consciousness has any useful **functions** whatever (which has never been demonstrated but is probably true), then *economy* in consciousness will be of the first importance. No **organism** can afford to be conscious of matters which it could deal with at unconscious **levels**" (1967, p.116).

This is obviously why our **brain** constructs first physiological, next behavioral and finally mental **algorithms**.

The necessity for economy in consciousness has been neatly epitomized by the Argentine writer J.L. BORGES in his fascinating short story "Funes, el memorioso", in which he recounts the case of a man who recorded the least small details that he observed and became thus totally unable to think and to act.

0630

CONSCIOUSNESS (Evolutionary and Planetary) ¹⁾⁴⁾

K. BAUSCH synthesizes as follows B.H. BANATHY's views on the subject. BANATHY "distinguishes between two kinds of consciousness which coexist at the individual and the societal level". Before going further it should be useful to give some thoughts to the existence and nature of that societal level (see Observer (Collective))

According to BANATHY: "the self-reflective consciousness contemplates "what is and creates an **image** of the self, the world around the self, and one's **role** in the world"

Possibly BANATHY's optimism should be put in perspective by a skeptical comment of A. EINSTEIN: "Der Horizont vieler Menschen ist ein Kreis mit Radius null-und das nennen sie ihrer Standpunkt"(The horizon of many people is a circle of zero radius- and they call this their viewpoint")

BANATHY follows on: "The creative consciousness focuses on "what should be". Here a second question mark appears: On the base of which criteria do we define (personally and in groups) "what should be". And what happens if no common criteria are accepted? and "...creates a guiding evolutionary vision of the desired future"...

As to the "planetary consciousness which involves the knowing and feeling of the vital interdependence and essential oneness of humankind, and the conscious adoption of the ethics and ethos that entails", it is of course probably the basic condition for planetary **survival**. However it remains to be seen if and

when this "knowing and feeling" could be achieved in a sufficient majority of the planet's inhabitants (in order to transform any utopia in a workable reality)

Moreover that "knowing" is impossible without a much deeper understanding of the deep causes of the woeful present **situation** of mankind. Such understanding can be much enhanced by the use of systemic-cybernetic **concepts**, **models** and **tools**, including in it a better **awareness** of the conditions of our own consciousness.

Finally adequate thinking (i.e. coherent, not self contradictory, wide embracing and open to progressive **adaptiveness**) seems to be the necessary bedrock for a responsible management of the issues at stake.

0631

CONSENSUS ^{1) - 4)}

A common opinion acquired by a **group** of persons after examination of the **elements** of a **situation** or problem and discussion of their **meaning**.

Consensus implies a way to acquire it. It results from **recursive** and mutually transmitted experiences on the same **objects** by different individuals, producing results that are considered similar by the participants. This is possible only if they share a sufficiently common perceptual and conceptual **background**.

G. PASK states: "... just because of our human limitations there is advantage to be gained if a **group** of **observers**, anxious to make the same sort of **predictions**, communicate with one another and in place of many private **images**, built up one commonly understood **abstraction** (such as the hypothetico-deductive **structure** of science). This will be a public **image** of the world within which all **observations** are assimilable and in terms of which **behavioral predictions** are made" (1961, p.22).

Consensus is the unavoidable condition for common **action**. However, it tends in many cases to lead to sclerosed stereotypes whose discussion is not anymore allowed. In some cases kinds of pseudo-consensus can be even hammered out and forcefully imposed: A famous historic case has been the so-called MITCHOURINE – LYSENKO theory of natural **selection** in the former Soviet Union during the fifties.

Genuine **creativity** can be easily stifled if consensus is submitted to excessively limiting **constraints** within an **organization** or culture.

Insufficiently informed consensus leads to what J. WARFIELD calls "**underconceptualization**", or to G.de ZEEUW's **invisibility**.

This danger is also implicitly emphasized by G. PASK: "An **observer** who subscribes to the plan, must limit himself to **observations** that are mutually intelligible and which can be assimilated" (Ibid).

G. VICKERS observed, from another **view-point**, that consensus reaching is a strenuous problem, because of "... the delays inherent in the **processes** of generating a sufficiently shared view of the **situation**, a sufficient consensus on the course to pursue, and sufficient common **action** to achieve it" (1967, p.62).

He notes that all these "... are collective **processes**, mediated by **communication**" (Ibid).

The betterment of **communication processes** and of techniques of **co-participative design** (**FUSCHL Group**) or **Generic Design** (J. WARFIELD) are thus generally paramount in order to obtain well- founded consensus in due time.

M. MARUYAMA contributes some curious psycho-sociological angles: "Consensus is an **homogenist**-type notion, which does not require disadvantage compensation" (1994, p.41). **Homogenist mindscapes** include as *natural* the disciplined acceptance of consensus. However MARUYAMA observes that this is not the case in all cultures, since some consider, on the contrary, that the person disadvantaged by consensus is entitled to an immediate compensation (in the Navajo-type **decision process**) or a delayed one (in Indonesian or Japanese culture).

0632

CONSENSUS AND COMPLEXITY UNDERSTANDING ^{1) - 4)}

Stafford BEER writes:

Science offers the means:

- to measure and manipulate **complexity** through mathematics
- to design **complex systems** through **general systems theory**
- to devise viable **organizations** through **cybernetics**
- to work **effectively** with people through behavioral science
- to apply all this to practical affairs through **operational research**⁴⁾.

The **knowledge** and the skills exist, but... "**Society** proceeds instead by **consensus**... The **consensus** simplifies, distorts and makes trivial the real problems of **complexification** which are inherently too difficult for all to understand.

"Thus we come to manage an oversimplified **model** of the world that exists only in the mind of the consensus, instead of the real world out there.

"This mismatch lies at the root of our incompetence" (1976, p.381/2).

Consensus is a *neutral* tool in itself. While it is the only practical way to reach common **understanding** in human systems and thus to be able to insure **autopoiesis** or innovation in them, it does not by itself guarantee satisfactory results: **consensus** may be disastrous,

since the needs of a **nonlinear complex system** are frequently **counter-intuitive** and conflictive with common sense (generally addict to **linear** ways of thought).

0633

CONSENSUS AND CONSENSUALITY ^{3) - 4)}

Following R. HARNDEN: "With respect to a **constitutive ontology** as proposed by Humberto MATURANA and based on a refined physio-psychology of **perception** and conceptualization, consensuality is about shifting currents of discourse and **understanding** in the present they realize.

"This is not the same as "consensus", which implies transcending such shifting currents in order to secure some sort of "**meta**" vantage and be able to pronounce this the "**norm**" or "average" (as agreement)" (1990, p.298).

In other words, consensuality is a psycho-social **process**, whose result is consensus, a stable **evaluation**, which may of course be reviewed at any moment by reversing to the consensuality **process**.

Consensuality protects human groups from conceptual sclerosis and their **organizations** from blockage.

However, it would be excessive to admit that any scientific theory or **model** can be refuted (or falsified in Popper's terminology) simply by some new psycho-social consensus. In AULIN's words "NEWTON was never refuted by EINSTEIN" (1987, p.76): There is "something" in the real world that, at some **scale** and within defined conditions, endows some **models** with a bedrock **stability** that no shift of consensus could alter. After all, classical gravitation calculus is what permitted the successful steering of the PIONEER and VOYAGER probes, **three bodies problem** notwithstanding.

0634

CONSENSUS METHODOLOGIES ¹⁾⁴⁾

Various authors coincide on the need of creating consensus among people who may hold different and even divergent views about **issues** that are of concern to them (knowingly or not).

The first step should be to establish a honest and as complete as possible list of **stakeholders**, including probable future ones in accordance with the also probable developments of the **situation**, or as a result of the **decisions** to be made, and the **actions** to be furthered (MITROFF & LINSTONE, 1993)

Thereafter, it is absolutely essential to avoid **blindspots** and **underconceptualization** about the nature and characteristics of the issue or situation (J. WARFIELD, 1989 a, 1994b)

And of course, no consensus can be reached (and maintained in an evolving way) without free and widely open exchanges of opinions among the stakeholders (G. PASK, 1975, 1976;

J. WARFIELD, 1994b) In order to promote these exchanges, B.H. BANATHY organized and developed the **FUSCHL** and the **ASILOMAR Conversations**, as practical training group activities.

→ **Conversation**; **Generic design science**; **Group technique (Nominal)**; **Design (Co-participative)**; **Design methodology (Systemic)**

0635

CONSERVATION LAW ^{2) - 5)}

The **first law of thermodynamics**, which prescribes that in an **isolated system**, the quantity of **energy** neither increases or decreases with **time**.

Two caveats are of great importance.

First, the law is frequently enounced as referring to **closed systems**. This introduces an **ambiguity** in relation to the possibility of observing the system. (An **isolated system**, without **inputs** or **outputs** would be unobservable: it is in fact a pure **abstract model** wherein "closed" means "isolated").

Secondly, this law is strictly quantitative: it says nothing about the *quality* of the **energy**.(- see **2nd law of thermodynamics**).

0636

CONSILIENCE ²⁾

The establishment of **consistency** among explanations of different **phenomena**

E. WILSON writes: "The explanations of different phenomena most likely to survive are those that can be connected and proved consistent with one another" (1998, p.6)

This is a social aspect of scientific **knowledge**, as the **consistency** must be established and recognized within the frame of accepted **criteria of relevance** and adequacy in some organized body of **knowledge**.

0637

CONSISTENCY ^{2) - 4)}

Character of a system devoid of any internal contradiction.

In J.L. CASTI words: "We... call the system consistent if a statement S and its negation are not both theorems of the system" (1994, p.139). As noted by CASTI, the consistency condition is closely related to **GÖDEL's Incompleteness theorem**: "Construct an arithmetical statement asserting that "arithmetic is consistent". Prove that this arithmetical statement is not provable, thus showing that arithmetic as a *formal system* is too weak to prove its own consistency", is a significant step in GÖDEL's proof (p.142).

The concept has also been discussed by M. MESAROVIC, on the base of three, interrelated **sets of systems inputs and outputs**:

In short, consistency may not be compatible with completeness.

It has been observed that "when a group of **models**, each of them internally consistent, is aggregated into a single composite model, there is no assurance of conservation of overall consistency" (J. WARFIELD, after G. FRIEDMAN-pers. comm.)

This possible lack of **compatibility** results of the fact that some specific model may well ignore **constraints** that are taken into account in another model when connected, implicit contradictions may emerge.

F. HARARY enounced and demonstrated in terms of **Boolean algebra** a "Theorem of Model consistency" stating the conditions in which consistency is conserved (1965)

- the **set** of acceptable **inputs**
- the **set** of undesirable **outputs**
- the **set** of desirable **outputs**

No consistent system can produce at the same time desirable and undesirable **outputs**. (A curious consequence is that nearly all of our human systems are inconsistent...).

MESAROVIC enounced the following theorem: "A system for which the **set** of undesirable **outputs** W and the **set** of acceptable inputs X' are specified is either inconsistent (contradictory) or incomplete" (1968, p.367-71).

There is anyhow some doubt that *any* system can be devoid of some internal contradictions. According to H.G. BURGER, who created the concept of **agonometry**, consistency may be only a **strain**, not an attainment (1967, p.221).

G. BROEKSTRA observes that the rationality of **equilibrium** in human **organizations** led to the belief: "... that **fluctuations** in the form of misfits, inconsistencies, **paradoxes** or contradictions, had to be **dampened** or suppressed... driving an **organization** towards a particular **stable attractor state** (configuration). However, although a tight **fit** may lead temporarily to excellence... paradoxically, in the long run, **fit** may lead to failure" (1993, p.76).

BROEKSTRA understands that consistency should "... be reconceptualized in terms of the **concept** of **autopoiesis**, or rather, for **social systems**, as a case of **organizational closure**" (p.78).

In short, **resilience** is better than strait-jacket consistency for the survival of any system.

→ **Incompatibility (Principle of)**

0638

CONSTANCY²⁾

The unchanging **level** of some **variable** or character of some **subsystem** for a **time**.

ASHBY explains: "If some of the **variables** or **subsystems** are constant for a **time**, than during that **time** the **connections** through them are reduced *functionally* to zero, and the effect is as if the **connexions** had been severed in some material way during that **time**... Thus a **whole**, connected system may, if a sufficient

proportion of its **variables** go constant, be temporarily equivalent to a **set** of unconnected **subsystems**. Constancies, in other words, can cut a system to pieces" (1960, p.169).

This is one of these original, stimulating... and somewhat paradoxical ideas of ASHBY. Of course, a *dosis* of constancy, let us say for example of **structural** constancy in our skeleton, is obviously helpful. But arthrosis would not be.

0639

CONSTRAINT^{1) - 2)}

"A limitation or restriction imposed upon a system or a **sub-system** that curtails **resources** or **operations**" (Adopted from B. BANATHY, 1973, p.85).

More specifically, constraints limit the possibilities of **interactions** between **elements** or **subsystems**. They also limit the **interactions** of the system with its **environment**.

In a more formal way, W. ROSS ASHBY, who introduced the concept, defines it as follows: "A relation between two **sets**, (occurring) when the **variety** that exists under one condition is less than the **variety** that exists under another" (1958, p.127).

ASHBY gives the example of the traffic lights: with three different colours and two different **states** (lit, unlit) for each one, eight **combinations** are possible. However, only four are used: Red and green are not compatible simultaneously; two of the three lights may always be lit or unlit simultaneously; all the three lights cannot be used simultaneously (the **message** would be self-contradictory); and when all three are unlit, there is no **message**. Thus, constraints imply restrictive **rules**. For simple cases, this is very clearly described in a **matrix**.

As a result, when all the possible **combinations** or **interrelations** are not used or admitted, an **observer** should look for constraints.

J. BRUNET writes: "...the **set** of the **constraints** has the effect of reducing the number of **freedom degrees** associated to a system, therefore to diminish its **variety level** and, thus its **entropy**".

"Within the frame of the 2nd. postulate (of **thermodynamics**), the **set** of the constraints appears by means of the **invariants** to which the global system is submitted; these **invariants** are associated to the great law of **conservation** in nature (mass, **energy conservation**)" (1987, p.21).

Considering the gigantic **variety** that would result from the unrestricted **set** of all the possible **interrelations** between the **components** of any **complex system**, its internal **flows** of **information**, **energy** and **matter** would become clogged and blocked if no constraints should exist.

Thus, as stated by L.J. KOHOUT and B.R. GAINES, constraints "... limit the unwanted or the dangerous **interactions** which would otherwise destroy the most essential **functions** and characteristic features of a system" (1976, p.18).

Constraints are mostly reciprocal, be it between the system and its **environment** or among **sub-systems**, but they may also be **hierarchical**, as for example in the case of the constraints imposed by **regulators** on the regulated **variables**.

As observed by F. HEYLIGHEN, constraints have an **evolutive** or historical origin: "... the system may simply be the result of a natural **selection**, where unstable **configurations** have been eliminated so that only a restricted or constrained **set** of **configurations** remains. The **concept** of an "attractor" as a region in **state space** that a system can enter but not leave, exemplifies such a spontaneously arising constraint" (pers. comm. p.10).

Of course, constraints are also learned, be it through evolutive **selection**, or individual **activity**, or as a computational technique ("multiple constraint-satisfaction"), within the limits of **organizational closure**.

In fact, learning consists of, and implies the acquisition of constraints. In M. BODEN's words: "A **connectionist network** trying to understand an **analogy** can consider many different constraints in **parallel**, and settle on the best available match even though this match may be somewhat flawed (and, by hypothesis, is never perfect).

A system in which every **element** should be connected with every other one, would be at the same time totally constrained and completely undefined, i.e. would have no **heterogenety**, no **structures** and no differentiated specific **functions**. It would indeed be no system at all. Constraints are thus an absolute necessity for systems.

Paradoxically, however, the same situation would result if no **interconnections** at all should exist.

In synthesis, constraints in systems, when not excessive and stiffling, are **freedom-limiting**, but **order-creative**. They constitute **algorithms** for some productive ways to act. Striking examples are classical, or dodecaphonic harmony, or the hindu raga-style.

M. BODEN even states: "...far from being the antithesis of **creativity**, constraints on thinking are what make it possible" (1990, p.82).

The constraints characterizing a system are potentially present at the time of its **autogenesis**, for reasons and in ways that are not yet very well understood. They become actualized through the **process** of **morphogenesis** and lead to **autopoiesis** through **organizational closure**, but this results also from the system

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

interactions with its **environment**... But, the more the system closes on itself, the less it remains able to adapt to a more global, and changing **environment**.

ASHBY, who much developed the constraint concept, states: "...the **organism** commonly faces a world that repeat itself, that is **consistent** to some degree in obeying laws, that is not wholly **chaotic**. The greater the degree of constraint, the more can the adapting **organism** specialise against the particular form of **environment** that do occur" (1960, p.139).

ASHBY also observed: "The constraint is thus a *relation* between **observer** and thing: the properties of any particular constraint will depend on both the real thing and on the *observer*. It follows that a substantial part of the theory of **organization** will be concerned with *properties that are not intrinsic in the thing but are relational between observer and thing*" (1968, p.109).

0640

CONSTRAINT ANALYSIS ²⁾

"A formal method for decomposing the constraint within a **whole** system into several constraints within **subsets** of its **variables**, (i.e., of an **ordinality** lower than the original) so that the latter fully account for the former" (K. KRIPPENDORFF, 1986, p.16).

KRIPPENDORFF claims that constraint analysis "thereby reveals the **component structure** of an observed system" (Ibid). The method is however **reductionist** and one should take care unless, by ignoring and severing **interactions** between local or specific constraints, something essential to the global constraint could disappear.

The method is closely related to KLIR's "**re-constructability analysis**".

0641

CONSTRAINT (Dynamical) ²⁾

"A **selection criterion** that determines which of the possible **state transitions** corresponding to different **operators** will actually take place" (F. HEYLIGHEN, 1990a, p.426).

"Dynamical constraints usually have the form of either:

- 1) differential (or difference) equations, relating the predicted **state transition** (time derivate of the **state**) to the present **state**
- 2) **conservation** principles, stating that a certain global property of the system (e.g. **energy**) must be conserved during the **transition**, or
- 3) **variation** or **optimization**. principles, stating that the **transition** will occur that minimizes (or maximizes) a certain **function** of the **transition parameters** (Ibid).

"A dynamical constraint corresponds to a **distinction** between an allowed **state transition** and an impossible one" (Ibid, p.427).

0642

CONSTRAINT (Emerging) ²⁾

A constraint produced by the progressive interplay of the **elements** of a system during its **morphogenesis**.

Such constraints are, for example, new **rules** of interaction (or their actualization, if they already existed potentially), new **communication** lines, new roles for the **elements**.

Of course, once established these **rules**, roles and lines, they tend to become permanent and obligatory and, consequently, to restrict other potentialities, or even to annulate them.

Emergence of constraints is an aspect of **organizational closure**, and in some sense, of the **algorithmization** of the system. It is a very significative aspect of instruction or training, as well as of **structuration**.

0643

CONSTRAINT (Hierarchical) ¹⁾

The **control** exerted by one **holon** over another lower in a **hierarchy**" (T.F.H. ALLEN & T.B. STARR, 1982, p.265).

These authors state: "The constraining **holon** behaves more slowly than the constrained **holon**. The constraining **holon** influences more than it is influenced in the act of constraint" (p.265).

The "constraining **holon**" is generally a **metacontrol** or **metasystem**, in J.van GIGCH sense.

0644

CONSTRAINT (Second order) ²⁾

A constraint imposed on the variation of constraints.

F. HEYLIGHEN, who introduces this **concept**, applies it to the **emergence** of systems (in the sense of TURCHIN's **Meta System Transition**). He writes: "We may conceive the **emergence** of such a **metasystem** in the following way. Assume that a system has insufficient internal **variety** to maintain itself in its given **environment**, and that it can only reach the adequate **configurations** by changing its defining constraint. If the constraint changes in a relatively slow, continuous way, we might say that the system survives the **changes**, even though its identity has changed in the **process**.

(Comp. note: it would seem in this case that the system only has **accommodated** or **adapted** itself). "But the variation of the constraint itself undergoes **selection**, and that means that most likely an eventual stable **configuration** of second-order variations will be reached, defining a second-order constraint. This defines a new **metasystem**.

"When this **process** is combined with the **process** of a **supersystem transition** we will find that several systems undergoing second order variations collectively develop an overall constraint on their mutual **variations**. Here we

come back to TURCHIN's original structural characterization of a **metasystem transition**, where a number of **subsystems** are integrated, under the **control** of a higher order **mechanism** of constrained **variation**" (pers. comm., p.16).

We have, in this way and simultaneously, the opening of new possibilities of **variety** creation and their ordering by second order constraints.

0645

CONSTRAINT THRESHOLD ²⁾

The **configuration** in **space** and the instant in **time** where and when the **behavior** of a **composite system** suddenly changes.

P. COUSSOT and J.M. PIAU comment: "When the concentration of particles increases, the median **size** of the **clusters** increases and, suddenly, beyond a defined **concentration**, a global **net** of **interactions** appears, which connects the whole sample. This is a **percolation phenomenon**.

"The fluid possesses a constraint threshold that represents the minimum constraint that must be applied to break the **net** and start a **flow**" (1993, p.1086).

The concept is of great importance for the study of **avalanches** of snow or mud, heaps of semi-viscous materials, gels, pastes and doughs, etc., where such thresholds can readily be observed.

Constraint thresholds, as a rheological effect seems however to be quite a more general type of **phenomenon** and be akin to the concepts of **catastrophe** and **bifurcation**.

It would be interesting to research possible constraint thresholds in **living** and **social systems**.

0646

CONSTRAINTS (Antagonistic) ²⁾

Constraints that are mutually constraining.

An example is the necessity to insure fast and massive transportation and the resulting growing **overcrowding** of lanes and streets. Another is the antagonism between high **multiplication rate** and **survival** of the species (as in *Dyctiostelium discoideum*... and probably in the human species).

Increase in antagonistic constraints may lead to a sudden change in global **behavior** and is possibly a significant factor in **anagenesis**. If antagonistic constraints are not to be destructive they must harmonize, i. e. enter in a compatible **interrelation**, i.e. be submitted to a higher **level regulation** or constraint, i.e. become **part** of a wider system.

0647

CONSTRAINTS (Cognitive) ^{1) - 4)}

R. ESPEJO focused the attention on the fact that: "...all viewpoints will recognize only a limited number or the possible outcomes of a

black box. But different viewpoints will recognize different numbers. Therefore, in measuring **complexity** it is always necessary to choose the appropriate viewpoints" (1988, p.141).

(Note: In concordance with St. BEER, ESPEJO uses the **black box model** as "... a shorthand for the real world" (Ibid.).)

Viewpoints are diversely affected by perceptive, cultural, social, and the resulting conceptual limitations.

Being thus constrained, the **cognition of complexity** in systems and in **situations** can never be complete. As to "appropriate" viewpoints, we are always in dire need for individual and common **criteria** if we seek **consensus**.

→ "**blindspot**", "**invisibility**" and "**under-conceptualization**".

0648

CONSTRAINTS: (Internal and external)^{1) - 2) - 3)}

Any system is submitted to two different classes of constraints, i.e. internal constraints which organize its necessary **heterogeneity**, and external ones, which result from the more or less stable or unstable conditions in its **environment**.

The internal ones are defined by the central **control subsystem** (see **stellar type system**), which ensures **autopoiesis** on the base of the formerly registered **evolutive** traits corresponding to the system's **class**. These constraints are, for example, genetic, normative, statutory through by-laws, etc...

The external constraints are the present limitations imposed upon the system by its **environment**. They may well be at variance with the historical or **evolutive** constraints already registered within the system and thus be a source of serious problems.

I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN insist rightly on the importance of this feature: "Experience shows that many complex problems of today are not solved at all or are solved incorrectly or ineffectively only because they have been wrongly formulated, because not all the essential aspects of the ...constraints imposed on its solution have been taken into account" (1977, p.262).

This is also a result of the "**isolated**" or "**closed**" system fallacy, leading to study the system only from inside, in a kind of aseptic vacuum.

0649

CONSTRAINTS (Self-generated)¹⁾²⁾

Those **constraints** imposed on the system by its own **activity**.

G. ARMALAGOS writes: "As long as a virus has an effective **mechanism** for jumping from one person to another, it can afford to kill its victims" (1998, p.25).

If it however does kill too quickly, it limits severely its own expansion: "Gruesome pathogens such as Ebola are unlikely to cause a widespread **epidemic** because they sicken and kill so quickly that victims can easily be identified and isolated" (Ibid., p.24)

Historically, the same effect operated in a different way: After the "Black death" pest **pandemics** in Europe (1347-1352), successive resurgences of the disease killed less and less people, probably at least in part because the survivors of former epidemics offered a growing resistance to it and somehow transmitted it to their descendants.

The growing **resistance** of pests and pathogens to a number of our new 20th. Century medicines is probably another example.

More generally, new collective **constraints** emerge from the massive success of some innovation. The growing traffic problems resulting from the evermore massive use of cars is an example. This corresponds to J.van GIGCH's **side** or **spill-over effects**, or to the French sociologist R. BOUDON's perverse effects.

Such self-generated constraints are due to multiply in our expanding **ecosystems** and **sociosystems**, under the pressure of accelerating quantitative **growth**.

0650

CONSTRUCT³⁾

A mental way of ordering a number of **elements, observations** or **data** in some manner coherent with previously structured **knowledge**.

In E.von GLASERSFELD words: "... constructs... are results of mental **operations**" (1988, p.4).

This does not mean that constructs are independent from what we call "reality", but only that they are something different from it. This is thus no idealist Berkeleyan proposition.

The **concept** of construct starts from the understanding that a simple incoherent collection of any kind of **elements, observations** or **data** would be useless for any **purpose** and that the **observer** is necessarily ordering them somehow. This "somehow" depends on an **organizational closure process**, i.e. of the internal physiological, psychical and mental (seemingly in that order) **organization** of the **observer**.

The physiological part has to see with the specific ways of sensorial **perception**, which impose by themselves **constraints** and thus, **coherence** (J.J. GIBSON, 1986). The **process** proceeds through psychical and mental ordering in the endocrine and nervous **subsystems**, which again implies specific ways of ordering.

So-called "**facts**" are elemental constructs, corresponding to something "out there". **Memories**, hypotheses, **algorithms**, **models**, theories, **languages**, etc... are more elaborated constructs.

Constructs gain social value through **conversation** and **consensus**. They are always **falsifiable** in POPPER's sense.

→ "**Ontological skepticism**".

0651

CONSTRUCTIONISM¹⁾

According to E.von GLASERSFELD, this term has been "invented by K. GERGEN to distinguish his way of thinking from that of other constructivists" (1999, p. 11)

According to GERGEN "The constructionist is centrally concerned with such matters as negotiation, **cooperation**, **conflict**, rhetoric, **ritual**, **roles**, special **scenarios**, and the like, but avoids psychological explorations of microsocial **process**" (1995, p. 25)

Thus, constructionism seems more "**conversational**" (in PASK's way) than **autopoietic** (in von FOERSTER's and MATURANA's way) somewhat at variance with **constructivism**.

Anyhow, both concepts are closely related and, as in the case of the egg and hen, it is quite difficult to distinguish what came first.

Indeed, von GLASERSFELD concludes: "What speakers have learned to mean always remain their own construction" (p. 16)

(See the special issue of "Cybernetics and Human knowing" 6(1) 1999 on "Radical constructivism in education" for more on this subject.

0652

CONSTRUCTIVISM^{1) - 3) - 4)}

A theory of **knowledge** and a **methodology** for its acquisition based on a better **understanding** of our ways of **perception** and interpretation of reality.

J. WARFIELD states that constructivism embodies the following beliefs: "a) a **universe** exists, which includes human beings capable of observing small **parts** of that **universe**; b) observation by the human occurs through sensory **perception**; c) The aggregate of all prior and present sensory **perceptions** is translated into **patterns** by each individual **observer**, this **aggregate** constituting the "virtual world" of that **observer**" (1994, p.63).

According to K. KRIPPENDORFF, "Constructivism is a reaction against the Gibsonian view that **knowledge** and **perception** are the result of sensation" (1986, p.15). However, GIBSON's views, while seemingly incomplete, appear as fundamentally correct: it is not possible to imagine any **perception** and **knowledge** without the use - eventually indirect - of sense organs, tuned to the physical world by eons of biological **evolution**. This is not to deny that sensations, transformed into **percepts**, finally produce **constructs**.

→ KORZYBSKI's "**structural differential**".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

On the other hand, H.von FOERSTER (1981) insisted on the need for any living being to organize itself in such a way as to be able to maintain a stable and coherent **survival** relation with its **environment**. It would be impossible for it to recreate such internal **organization** everytime it experiments a new sensation. Should this be the case, the **survival** value would be nil.

E.von GLASERSFELD thus introduces the basic tenets of constructivism: "(the **object**) has to be produced by the **organism's** own construction regardless of whether we believe that the **concept** corresponds to a thing-in-itself that exists "out there" independent of any **organism's** experience...

"From the point of view of the experienter, there can be no **object** until he himself coordinates several experiences and thus **constructs** the **invariant concept** of the **object**" (1976, p.116).

This is quite similar to A. KORZYBSKI concept of the **process** of progressive **abstraction** (1950). We should, as a **semantic** exercise, always put the word "**object**" inbetween quote marks.

von GLASERSFELD adds: "Seen from the point of view of the developing **organism** at the beginning of his cognitive career, it makes no difference at all whether regularities, **invariances**, and **rules** "exist" in a "real" world or not, since the only place where the **organism** can find them, learn them and **know** them is in his own experience" (Ibid).

We are thus led to **ontological skepticism**, but not, of course, to ontological nihilism, nor even agnosticism. This point is thus made by G. KLIR: "To avoid any confusion, it should be emphasized that the constructivist view does not imply that the existence of the real world, independent of the human mind, is necessarily denied. This is a different issue on which constructivism remains neutral. Constructivist view is not an **ontological** view (concerned with the existence and ultimate nature of reality), but an **epistemological** view (concerned with the origin, **structure**, acquisition, and **validity of knowledge**)" (1993, p.30).

And still, according to von GLASERSFELD: "Even if we postulate a fully structured, pre-existing world, the growing **organism** can build its **representation** of that world from no other material than the proximal **data** of its experience" (Ibid., p.119).

This is in line with J. PIAGET **understanding** of construction of reality in the child. It would also be enough to add "sensorial" to "experience" in order to coordinate GIBSON's and von GLASERSFELD's views.

On the other hand, as stated also by von GLASERSFELD, what we consider as "objective" arises from the confirmation by others from our own experience. It is the intersubjective repetition from experiences which delivers

the surer guarantee about the "objective" reality (1991, p.33). As a result, as resumed by M.C. JACKSON: "von GLASERSFELD further believes that, since one has to hypothesize "others", whose **understanding** and **actions** are close to one's own, to provide the highest forms of confirmation of the reality constructed (enough to call it "objective"), it is possible to postulate a constructivist ethics" (1988, p.120).

M.C.LE DUC proposes the following logical principles of constructivism:

"1. The principle of **recursion**:... the mental world organises the concrete world by organising itself

"2. The principle of dialogics: Sometimes **truth** is a dynamic **process** of two opposing and complementary mental **structures**.

"3. The principle of **truth by action**. VICO put it best (verum ipsum factum). A mental **construct** is true if it has been proved effective in **action** and effective action elicits **truth**" (1992, p.920).

As a result, radical constructivism is to be a theory of **knowledge**, but not a theory of being ("Sein").

Constructivism (Radical)

E.von GLASERSFELD, the main proponent of constructivism, explains as follows this extreme posture: "The substitution of the **concept** of **fit** (and its dynamic corollary, **viability**) for the traditional **concept** of **truth** as a matching, **isomorphic**, or **iconic representation** of **reality**, is the central feature of the **theory of knowledge** I have called Radical Constructivism" (1988, p.77-8).

In a recent reconsideration E.von GLASERSFELD wrote: "Constructivism is an **epistemological model** and can no more be empirically refuted than LEIBNIZ's Monadology, NICHOLAS of CUSA's theory of "docta ignorancia", or any other theory of knowing. They are conceptual **networks** built on **assumptions** which one

may or may not like; they have no **truth** value; what matters in their internal **coherence** and whether we find them useful"(as quoted by R. GLANVILLE, 2001, p. 142)

J. MINGERS makes this point even clearer: "Constructivists tend to argue (as does von GLASERSFELD) that their's is purely an **epistemology**, concerning limits on our **knowledge** of the world, not an **ontology**, concerning what may or may not exist"(1996, p. 21)

In fact, the deep nature of the very **observers** escapes the ontological query only through a kind of basic agnosticism.

→ **Ontological skepticism**

0653

CONSTRUCTIVIST CYBERNETICS (Epistemology of)³

Second order cybernetics generally implies a re-examination of scientific **epistemology** and **methodology**. While such a revision should also include physical sciences, it is never more important and necessary than in human sciences, because these study **situations** wherein participants are thinking beings who study themselves.

Stuart UMPLEBY elaborated the following comparative table between three quite different contemporaneous approaches (1990, p.116):

see table below

0654

CONSTRUCTS (Conceptual)³

"The reconstruction of direct experience in systems of **symbols**, culminating in science" (J.S. SUTHERLAND, 1973, p.55).

J.W. SUTHERLAND admission that science is basically the culmination of a **process** of conceptual construction, based of course on **observation** on a **phenomenological level**, is noteworthy and very useful from an **epistemological** and **ontological** viewpoint.

→ **Compressibility**

Table: see entry CONSTRUCTIVIST CYBERNETICS (Epistemology of)

POPPER	KUHN	CONSTRUCTIVIST CYBERNETICS
A normative view of epistemology : how scientists should operate	A sociological view of epistemology : how scientists in fact operate	A biological view of epistemology : how the brain functions
Non-science versus science	Steady progress vs. revolutions	Realism versus constructivism
Solve the problem of induction : conjectures and refutations	Explain turmoil in original records vs. smooth progress in textbooks	Include the observer within the domain of science
How science as a picture of reality is tested and grows	How paradigms are developed and then replaced	How an individual constructs a "reality"
Scientific knowledge exists independent of human beings	Even data and experiments are interpreted	Ideas about knowledge should be rooted in neurophysiology
We can know what we know and do not know	Science is a community activity	If people accept this view, they will be more tolerant

¹general information ²methodology or model ³epistemology, ontology and semantics ⁴human sciences ⁵discipline oriented

0655

CONSTRUCTS (Synchronous)^{1) - 2) - 4)}

Any social construct must necessarily be highly **synchronous**, i.e. respect collective **coherence** in **time**. This can be easily observed in human construction of any kind of **structures**, not only material but also economical, social or political. It is however also present in the **activities** of social insects, where it corresponds to **stigmergy**, and in the progressive development of any living being, from **embryogenesis** on.

In the case of gregarious **behavior** in fish shoals, or locusts, as well as in the case of the amoeba *dictyostelium discoideum*, **synchronicity** originates in the reciprocal **perception** of visual **stimulation** (fishes) or pheromones, starting possibly with a **positive feedback** among local **groups** of individuals.

The same mechanism can be observed on a freeway at rush hours. Individual drivers experiment simultaneously various conditions: perceptive (observing what is going on), mental (understanding the **situation**), psychological (taking care), physiological (some **stress**) and physical (acting) evoked by the movements of their close neighbors in the traffic lanes. Their **interconnected reactions** gradually gain ground in all directions and finally a **global flow** appears, into which every driver becomes dynamically **channelled**.

This "case study" seems to indicate that **synchronous** constructs are one of the most basic features of **human systems**, in still more ways than in the case of other social systems.

Social constructs, when tending to permanence, are the in-making **phase** of social **constraints**.

0656

CONTENT^{1) - 2)}

"That which flows, or circulates in a system, or constitutes it" (D. Mc NEIL, 1993, p.11).

In Mc NEIL's words: "Although **form** and **function** (or their respective homologues "**structure**" and "**process**") are the two most often acknowledged aspects of systems in the literature... the most often neglected (one) is the aspect of "substance" or content" (Ibid).

This author considers that any system can be modelled as a **toroid vortex** within associated **fields**, in which contents are more or less flowing according to their **structure** or **process** nature.

0657

CONTENTION⁵⁾

In a **network** where any **element** may have access to a central **store** of **data**, a **situation** of mutual locking which impedes the normal access to the needed **information**.

This may occur in Multiple Instruction Multiple Data (MIMD) **parallel processing machines**, but it can also occur in any **communication system** working in **parallel**.

0658

CONTEXT^{1) - 2)}

1. The **environment** of a **fact**, **datum**, **situation**, word, **information**, etc... that helps its **understanding**.

2. "A **metamessage** which classifies the elementary **signal**" (G. BATESON, 1967, p.260).

A sufficient context should include the effective **interactions** that could alter the **meaning** of any registered **observation**.

G. BATESON states: "Either we must discard the notion of "context", or we retain this notion and, with it, accept the **hierarchic series** - **stimulus**, context of **stimulus**, context of context of **stimulus**, etc. This series can be spelled out in the form of a **hierarchy** of **logical types** as follows:

"**Stimulus** is an elementary **signal**, internal or external

"Context of **stimulus** is a **metamessage** which classifies the elementary **signal**.

"Context of context of **stimulus** is a **metamessage** which classifies the **metamessage**.

"And so on" (Ibid).

A kind of **recursive algorithmic** perceptual and conceptual Russian matrioshka, so to say.

0659

CONTEXT DEPENDENCE³⁾

The condition required if a **symbol** or **concept** is to acquire an extended or more precise **meaning**.

F. HEYLIGHEN writes "(a **concept**) receives its **meaning** through the whole of **associations** it has with other primitive **concepts**. Those **associations** are the result of a slow **process** of **learning** based on many experiences of contiguous occurrences of two **concepts**" (pers. com.).

Biological **information** is also **context-dependent**. The sender and the receiver alike are influenced in their **information transfer** by numerous **contingent** conditions of very varied and variable nature.

The **understanding** of this **contiguity** of **concepts** and **symbols** is, by the way, very useful for the use of the present dictionary.

0660

CONTEXT (Evolving)^{1) - 2) - 4)}

Context (**environmental** and **invironmental** as well) is not invariable. Any system must adapt repeatedly. Species **co-evolve** within **ecosystems** and through mutations provoked by various context factors; individuals learn new ways and **behaviors** as they perceive new **situations**

and societies readapt their **organization** and, in some cases, their basic beliefs and **values** under inside or outside duress.

Generally speaking, this is **co-evolution**: there could be no **evolution** out of context.

0661

CONTEXT (Internal)^{1) - 2)}

"The context into which **information** is received" (G. BATESON, 1973, p.370).

As stated by BATESON: "... **information** comes out of a context into a context" (Ibid).

A system is basically, from this viewpoint, an **entity** in which internal context is different from the outside context. This is the reason why this compiler found it necessary to introduce the concept of **invironment**.

This is also the rationale behind J. MILLER's **input and output transducers** and **decoders** and **encoders**.

0662

CONTEXT MARKER^{3) - 4)}

A **signal** which helps to give a specific **meaning** to some **percept**.

This **concept** has been introduced by G. BATESON, who gives some examples of such context markers:

" - The Pope's throne from which he makes announcements ex cathedra, which announcements are thereby endowed with a special order of **validity**.

" - The placebo, by which the doctor sets the stage for a **change** in the patient's subjective experience.

" - The shining object used by some hypnotists in inducing trance

...

" - The handshake of boxers before the fight" (1967, p.261).

0663

CONTEXT (Meaning through)³⁾

Perception is meaningless without context, because it acquires some significance only through interconnected cerebral **networks** of former **perceptions** properly interpreted and ordered, this being the inner context.

There must also be an outside context. As stated by G. BATESON: "An **organism** responds to the 'same' **stimulus** differently in different contexts, and we must therefore ask about the source of the **organism's information**" (1967, p.260).

The context thus somehow imposes **constraints** on the interpretative **code**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0664

CONTEXT NEGLECT²⁾⁽³⁾

Context neglect is a general and sure-brand recipe for unsatisfactory based research, as well as theoretical problems and the production of awful **messes**, when applied to practical **issues**.

K. PRIBRAM, for instance, writing about **learning**, as viewed by psychologists, states: "... the **set of events** in which **information** occurs, is as important a determinant of the outcome of ... **experiment** as the **information** carrying **signal** itself. And yet it is usually this context that remains unspecified, unstudied, and often hopelessly shrugged off as being impossible to study" (1969, p.194).

No **situation** or **issue** can be aseptically confined and the needed "de-confinement" is at the same time one of the most important possibilities as well as a main responsibility of **systems inquiries** through adequate context-connected **concepts** and **models**.

0665

CONTEXT OF CONTEXT³⁾

"A **meta-metamessage** which classifies the **metamessage**" (G. BATESON, 1967, p.260).

0666

CONTEXT (Relevant)³⁾

That part of the context that helps to classify the **message** (After G. BATESON, 1973, p.218).

BATESON explains how the context may reinforces or modify the **message**, for example "... place the **message** in the category of humour, **metaphor**, etc. The setting may make the **message** inappropriate. The **message** may be out of tune with the larger context, and so on. But there are limits to these modifications. The context may tell the recipient anything *about* the **message**, but it cannot ever destroy or directly contradict the latter" (Ibid).

BATESON gives an interesting example: "I was lying when I said 'The cat is on the mat'" tells the vis-a-vis nothing about the location of the cat. It tells him only something about the **reliability** of his previous **information**" (Ibid). This means that the **message** is reclassified within a different relevant context: it should not have been taken at its face-value.

Of course, while "relevant context" for **human information** and **knowledge** is a matter of **paradigms**, "without context, there is no **communication**" (p.378).

However, it seems now to be correct even in genetics and embryology, as shown by the discovery of the importance of the reciprocal positions of genes and chromosomes.

→ **Positional value**

0667

CONTEXT (Repeatable)¹⁾

As noted by G. BATESON, context is repeatable, even if not entirely repeatable, as it is evolving.

BATESON states: "Without the assumption of repeatable context (and the hypothesis that *for the organisms* which we study the sequence of experience is really somehow punctuated in this manner), it would follow that all **learning** would be of one type: namely, all would be zero **learning**" (1973, p.259).

In other words, no **adaptation** and no **evolution** would be possible, and possibly no coherent systems of any kind. Repeatability is a very general feature of the physical, the biological, the psychological, the mental and the social spheres.

0668

CONTEXT SENSITIVITY³⁾

T. BAUMGARTNER et al. state: "Systems differ in the degree and quality of their **structural sensitivity**: from the deductive systems of pure mathematics where there is a systematic effort to remove all context **dependence** in order to emphasize the underlying abstract **relationships**, to the high degree of context sensitivity and structural **dynamics of living systems**" (1976, p.34).

Low context sensibility in **models** is acquired only by suppressing the context as far as possible. However such simplifications do not lead to satisfactory results in **complex systems modelling**.

The problem of context sensibility, viewed from the **modelling** angle is now under precise focus through **chaos theory**.

0669

CONTEXT-FREE ELEMENTS^{1) - 3) - 5)}

P. DENNING writes: "The failure of **artificial intelligence** to produce **machines** with any of these capabilities (e.g. many **behaviors** that are very simple for human beings) after forty years of research is not a failure of intention. It is a failure of the rationalistic philosophy deeply rooted in Western thought. That philosophy has produced in many disciplines a search for **models** that combine context-free (meaningless) **elements** into systems governed by formal laws. Not only have **information-processing models** of **cognition** fallen short in computer science, but corresponding **models** have also fallen short in anthropology, economics, linguistics, political science, psychology and other disciplines" (1989, p.333).

Of course, no **element** is ever context-free, as it is its **interactions** with other **elements** which give it its **value**, which is modified when these **interactions** change.

This conceptual quagmire explains the problems which arised from some theoretical formulations when unduly applied in factual **situations**. A good example is the **2d law of thermodynamics** and its consequences for the irreversible disorganization of **isolated systems** (a purely abstract **concept**, scantily related to **concrete systems**). The impossibility of the existence of life, supposedly resulting from the 2d law, created awful conceptual tangles in the minds of three generations of biologists: this riddle was resolved only after BERTALANFFY's and PRIGOGINE's work.

0670

CONTEXTS (Psychological)¹⁾⁽²⁾⁽³⁾

The Greek psychiatrist and systemist N. PARISIS (Zeugma, 2000) enounces the following contextual **links** that can activate, desactivate or transform the psychological orientation ("tropos") of a person:

He writes: "**Contexts** can be in the natural **environment** reflected in the mind, or directly in the mind as in the cases of:

- **situations** of the present or the past
- stages of **human systems** intelligent development
- the **supra-systems** in which the human system belongs such as families, work environment
- human systems **relations** such as friendship, love, hate
- particular **interactions** of the moment such as quarrelling, courtship, running
- emotional states such as anger, fear, love, anxiety, depression, peacefulness, hapiness
- **theories**, beliefs, **values**
- **cultures**, myths, **religions**
- political or social **organization**
- nations"

Psychological contexts (and cultural ones) are a matter of very serious concern considering the acceleration of general transformation of mankind as well as the multiplication of interrelations among millions of people of many different origins.

→ **Conversation; Culturocentrism; Frame of reference; Perception; Transculturation**

0671

CONTEXTUAL IMPLICATION³⁾

This notion was introduced by C.S. PEIRCE and retaken by J. WARFIELD, who explains it as follows:

"Every question involves contextual implication

"In the first instance, CI refers to:

a) The linguistic demand placed on the recipient of the question

b) The hypotheses that underlie the question

"In the second instance, CI refers to:

a) The (implied) questions to which those hypotheses are possible answers, and

b) The contextual implication of the implied questions

c) The hypotheses underlying those questions

"and so on until a possible point is reached where there is no contextual implication. If such a point is reached it is in the axiomatic domain" (pers com.)

This concept is basic to any systemic **inquiry** because it helps to avoid undue simplifications. However, a **limit** must be put to the **process**, i.e. must be clearly perceived and stated.

0672

CONTIGUITY²⁾

The closeness of **elements** in **space** and/or **time**.

Patterns of **interaction** are more easily formed among **elements** which are close to each other in **space** or **time**. This is a result of the non-instantaneous **propagation** of **effects** and helps explain **phenomena** like **random** or causal **linkages**, **clustering**, local system's formation, **gestalt perception**, etc.

Applying this to **perception** S. ARIETI states: "Sense-**data** experienced together tend to be re-experienced together, if they produced one **effect** in the **organism** by the fact of being together. The **effect** in its turn connects more firmly together the sense-**data**" (1965, p.109).

However: "The mode of **operation** by contiguity, which seems at first so simple, is something which instead requires the solution, through evolutionary **mechanisms** of a difficult problem... : **response** of a **part** versus **response** to a **whole**... In normal conditions, **whole – perception** wins out and the mode of contiguity generally applies to the contiguity of the various **parts** which form differentiated **wholes**" (Ibid).

In other words, contiguity is instaurated by **re-inforcement**. Moreover, contiguity **perception** must be the cause or condition of **Gestalt** construction.

0673

CONTINGENCY³⁾

Character of an **event** depending on **chance**.

Environmental **events**, for example, are sometimes contingent, which means that the system is unable to **forecast** them, as they do not enter in any determined **process**.

As observed by St. GOULD: "Contingency is the affirmation of **control** by immediate **events** over destiny, the kingdom lost for want of a horseshoe nail"

Contingency should not be confused with **indeterminacy**. The fortuitous event does not annulate **causality**. It merely triggers it in unpredictable circumstances.

For example the deeper roots of a **conflict** and in most cases the ways it will evolve are mostly independent of the specific circumstance that started it. A good example is the

first world war, triggered but not caused by the assassination by a Serb of an Austrian archduke in Sarajevo. Causes were of a very wider and deeper scope and war could have been triggered by any other fortuitous incident (See R. ARON, 1961)...or avoided at least for some time.

Contingency strongly limits the possibility of formulating absolutely rigorous laws in social sciences and **history**, wherein controlled **experiences** are impossible and **events** never repeat in an identical way.

Contingency has to see with the relation between a system and its **environment**. It corresponds to the generally very high **variety** in the environment...and also to the high internal variety of the system. O. THYSSEN (1995, p. 16) explains LUHMANN's view on the subject: "A stable system is not a system which does not change at all, but a system which is able to maintain its identity and **performance** in spite of high contingency in the environment and the system itself.. And "contingency forces a system to relate to a rich **repertoire** of **unstable** and uncertain **states**, so that the system faces a permanent pressure to choose"

Systemics tries to reduce contingency by replacing **events** in a more general **reference frame**. In this sense, earthquakes, volcanic eruptions and hurricanes, for instance, will remain contingent until better global theories would eventually decrease their **unpredictability**.

→ **Historical determinism; Predictability**

0674

CONTINGENCY (Mutual)^{3/4)}

The reciprocal **relation** which appears when two partners of **communication**, that Luhmann calls Ego and Alter, start their **relationship**. In L. QVORTUP words: "Ego communicates, but it communicates with the other as a projection of ego, i.e. with Alter ego. Here, contingency becomes mutual, or double contingency"(1993, p. 15). It may become a kind of mirroring mirrors.

This is quite similar to G. PASK concept of **conversation**. In fact, Ego and Alter are trying to understand each other, i.e. trying to express themselves in terms understandable to the other. If any result is to be obtained, it can be only in terms of reciprocal **adjustments** of **meanings**. Or in other words, the internal **reference frame** of both experiences an **adaptation** in order to represent the other. It is a kind of experimental **construction** of a significant relationship: one must be able to interpret the other, in terms that allow for an evermore fluid exchange. It means that Ego's own reference frame must ideally reflect in an adaptable way what one perceives of Alter's reference frame.

Moreover, only if this works in a satisfactory way, can it become a sound basis for **social systems**. As a result, in LUHMANN's words (as translated and quoted by Qvortrup): "...**cognition** has to be understood as the **recursive processing** of **symbols** (however materialized) in systems which are closed through the conditions of the connectability of their **operations**" (Ibid)

Anyhow Luhmann considers "that the **social systems** cannot think". This is probably the root of all social problems: thoughtful communication is scattered in a multidinous way and "public opinion" is that self-produced and re-produced unconscious monster made of myriad of small monsters described in BÖCKLIN's engraving. The results are generally enigmatic and sometimes frightful

0675

CONTINUITY^{1/2)}

The **long-term** general **dynamic stability** of a system.

Continuity does not exclude variations, even large **scale** ones. However, in this condition, the system retains its basic identity and nature.

Continuity corresponds to the **minimum entropy production theorem** enounced by PRIGOGINE. External **constraints** and/or internal **controls** are instrumental for continuity maintenance.

0676

CONTINUOUS – DISCONTINUOUS^{2) – 3)}

To discriminate basic continuity or discontinuity in nature is one of the most difficult – and even irritative – riddle in science and philosophy. According to R. THOM, this is a metaphysical problem. Curiously enough, this mathematician who created **catastrophe theory**, a **topological** theory of discontinuities, states that "the essence of catastrophe theory is precisely to reduce apparent discontinuities to a manifestation of a slow subagent **evolution**"¹⁾ (1991, p.62). For him, "the discrete character of a **transformation** is a simplification brought about by our perceptive system" (p.63). He adds: "We are made essentially to see discontinuities. Only these are significant. For an animal, it is essential to recognize preys and to localize them" (Ibid). As a result, our nervous system is organized toward the **perception** of the apparent **objects** outlines.

This is also true in **language**: "... we *discretize* phonemes" (p.64)... in order to become able to distinguish them. All in all, THOM's arguments do not seem conclusive. We have no definitive way to decide the matter.

It is even possible that this **dichotomy** is a perceptive **artifact**, in relation to **mega-**, **macro-** and **micro-levels** of **perceptions**.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

Systemists should remain careful when postulating continuity or discontinuity in **models** and **constructs**.

0677

CONTRACTION²⁾

Quality of an **adaptive nonlinear** system that tends to forget its timely working conditions in an exponential way (J.J. SLOTINE, 2002, p. 19)

SLOTINE writes: "If such a system is submitted to a temporary **perturbation** it will go back to what it was just doing- at that given moment" He adds: "...at least for small perturbations, such **robustness** is in fact a necessary condition for any **learning**: a system whose **responses** would be fundamentally different at each trial would be incomprehensible" (Ibid)

Moreover: "...the contraction property is automatically maintained by any combination (**parallel**, **serial** or **hierarchical**; and some types of **feedbacks**) or dynamical recombination of **subsystems**, when these are also contractant" (Ibid)

Generally, contraction is a **stabilization**, or even **self-stabilization** device in **nonlinear** systems.

→ **Le Chatelier (Principle of); Least action (Principle of); Regulation; Slaving Principle**

0678

CONTROL^{1) - 2)}**1 the concept**

D. Mc NEIL considers control as "... the re-ordering of **activity** with reference to ends". In the **toroidal paradigm** he proposes, "manifestations of control can be identified with the orientation and strength of a **toroidal** center, taken as a **channel**, a stem, a conduit, or even a gyroscopic axis complementary to a **looping flow of content**" (1993, p.11).

Aside from this very general view, we need a better **understanding** of the ways controls work, as related to **organization**, **stability** and **goals** or **purposes**.

J.Z. YOUNG writes that control is: "The **regulation** of the **operation** of a system by a **program** of instructions, often using **sensors** to detect **deviations** from a **reference** standard and initiate corrections" (1978, p.291).

St. KATZ writes: "In essence, control simply means the **regulation** of **magnitude**. Now to say that something is regulated implies that it may assume any of a number of values, i.e. it may vary or is variant. Yet, the very fact that we refer to it as "it" or "something" implies that the something being regulated has also a

permanent aspect about it, i.e., has a characteristic that remains constant or is **invariant**" (1976, p.43).

According to E. JANTSCH, control "is geared to **stability** and to the **optimization** of specific **parameters** under a **set** of fixed **constraints**" (1975, p.283).

All systems have controls, generally many ones, since they include a number of **processes** and **functions** that must be maintained within specific maxima and minima.

However, control is closely related to **variance** in the **environment**, which is generally the cause or the **trigger** of internal **variance** of the controlled system.

As any control is basically a **constraint**, the concept of control implies an **algorithm** relative to the necessarily predefined **limits**. However, such an **algorithm** may be implicit, as for example in the natural and reciprocal control of animal and/or vegetal **populations**.

In **machines**, control is normally ensured by some preconceived **mechanism**.

As a **constraint** (in ASHBY's terminology) any control prohibits certain **states** and **transformations** and allows others, under specific conditions.

Control also implies **hierarchy**, since the controlled **process** or **function** is submitted by some **command** device to limitations, that it cannot normally modify.

In many cases **hierarchic** control is **multi-level**: subsidiary or local controls are, in turn, commanded by more global ones. In H. PATTEE's words, **hierarchic** control aims at the: "**Optimization** of the **level** of **constraints** in forming new structural **levels** and in the **optimization** of loss of detail in forming new descriptive **levels**" (1973, as quoted by E. JANTSCH, 1975).

However, the concept of control is in some cases ambiguous or misinterpreted.

W.T. POWERS states: "A is said to control B if, for every disturbing influence acting on B, A generates an **action** that tends strongly to counteract the effect of the disturbing influence on B".

He adds: "It is important to understand from the start that this definition doesn't fit many of the common usages of the term. For example it is said in chemistry that temperature controls the rate of a chemical reaction. But that doesn't fit the definition: if some independent influence tends to change the **rate** of the reaction (stirring the mixture for example), the temperature will *not* change so as to counteract the effects of the **disturbance** on the reaction rate" (1995)

Control, as meant by POWERS, always implies the existence of a willful **controller** or a **goal-seeking** device purposely introduced.

0679

CONTROL^{1) - 2)}**2, the mechanism**⁵⁾

So-called "devices" are proper to man-made systems. Even so, some are abstract as, for example, controls on money supply by interest rates or the highway **code** which aims at regulating drivers habits by way of **norms**. On the contrary, no material **mechanisms** are conspicuous in natural systems like

populations, or biotopes: here the control is diffuse and statistical in character (see **Markovian process**).

Living systems have biological control devices, which regulate, for example, blood pressure, glycogen rate or perspiration. But these devices performance is automatic and non-volitive.

In any case, as stated by V.G. DROZIN, it is impossible to "... effectively control a **complex system** by using only promoters or suppressors" (1975, p.11).

0680

CONTROL (Alert)⁴⁾

According to E. HERRSCHER, "there are two **modes** of control in **organizations**: the **programmed control** and the alert control"(pers. comm., 2003)

He adds: "the alert control has no **routine**, no formal **procedures** established a priori, **no program**. Instead, it consists of an attitude of "being prepared for surprises" of having our antennas ready to react to any unforeseen **signal** that may be relevant for the organization's present or future **performance** or even **survival**"(Ibid)

Herrscher states that alert control has its original root in hearing and observes that "our ears cannot be closed (there are no "ear lids") and that in this way we are always able to perceive **emergencies**, as "sound reaches our senses whether we like it or not"(Ibid).

On the contrary, programmed control is not automatic and depends on our will and our **goals**, within the **limits** of our **frames of references**.

→ **Perception; Perceptual fields**

0681

CONTROL: basic elements.(its five)²⁾

According to O. JOHANSEN BERTOGLIO (1985, p.184-85) a control system includes five basic parts:

a) a **variable**: this is the **element** (or programmed **goal**) that must be controlled. Let us say a car's velocity

b) **sensors**: or **mechanisms** or devices able to perceive the **variable's fluctuations**. In the car's velocity case, we need a velocimeter, our visual capacity and our **brain's** interpretative capacity

c) **motors**: or **effectors**, able to develop corrective **action**. In this case, they include neurons, nerves and our muscular system to move our foot to accelerate or brake

d) an **energy source**: needed for any kind of **activity**. We need our stored physical **energy** and also, the **energy** that moves the **motor**

e) **feedbacks**: which, by **communication** of the **variable's state** registered by the **sensors**, **trigger** the corrective **action**. In this case they are the **decisions** made by our **brain**.

0682

CONTROL BY ERROR ^{2) - 5)}

Referring himself to the practical difficulties to achieve control by error, at least in some cases, W.R. ASHBY observed: "... the designer engineer may sometimes forget that there is another way to **regulation**. May I suggest that he would do well to bear in mind what has been found so advantageous in the biological world, and to consider whether a **regulation**, which is excessively difficult to design if it is controlled by error, may not be easier to design if controlled not by the error but by what gives rise to the error" (1958, p.93).

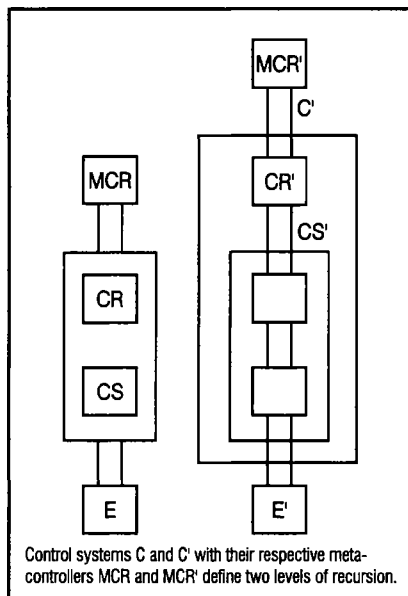
ASHBY observed that living **organisms** developed **channels** of **communication** with their **environment** to obtain "... **information** about **disturbances** before the chain of **cause** and **effect** goes so far as to cause actual error" (Ibid).

0683

CONTROL BY RECURSION ²⁾

A control organized at successive **meta-levels**.

This type of control is proper to **hierarchical systems**. J.P.van GIGCH explains: "In each control system, control exercised by the **controller** (CR) is called control at the **object level**,



From J. P. van GIGCH: 1986, p. 90

whereas control exercised by the metacontroller (MCR) is called control at the **metalevel** or **metacontrol**. The same denomination applies to subsequent **levels of recursion**" (1986, p.90).

→ "**Recursion (levels of)**"

0684

CONTROL (Chaotic) ¹⁾²⁾

A way to control a **chaotic system** by short bursts of intervention in its **behavior** at calculated moments.

This technique has been established on a mathematical basis by E. OTT et al. (1990).

It has been successfully applied to artificial satellites orbits in order to reduce fuel consumption when orbital corrections are needed. However, very complex **chaotic systems**, as for ex. atmospheric **perturbations**, cannot yet be controlled in this way, due to the considerable number of interacting **elements**.

0685

CONTROL (Forms of) ²⁾

Control can be introduced in numerous different ways. The following are indicated by L.E. BAYLISS (1966 - retranslated from the spanish translation - original unavailable):

- **auto-adaptive**: Return of a system's **function** toward its most adequate value by automatic **change** of the **parameters** (1968, p. 118).
- **integral**: Control operated upon a deviation, that becomes mathematically integrated in **time** (p.42)
- **nonlinear**: Intermittent control according to the existence of **thresholds** and saturation points in the **process** (p.42). (This is the on-off control).
- **proportional**: Control operated by a **regulating** device that produces at one moment a **signal** proportional to the deviation (p.38).
- **variable**: Control operated by a **regulating** device on the base of **memory** of former deviations (p.42).

Volitive controls could be added, being those that man establishes in artificial or natural systems that he wants to modify to his advantage.

0686

CONTROL (Hierarchic) ¹⁾²⁾

The control at each level by a higher **level** control.

P. CORNING writes: "...the principles that control higher **levels** may serve to restrict, **order** and "harness" lower levels". He uses an example by POLANYI (1968): "The grammatical **rules** that govern the **structure** of various human **languages** utilize but also subsume the principles of phonetics".

Thus, without **phonemes** there is no language.

But phonemes without some superseeding ordering cannot become a language.

This is another example of SABELLI's "**priority of the simple**" and "**supremacy of the complex**" (1994).

It also corresponds neatly with van GIGCH's **model** of control by **recursion** (1986). At higher levels, it becomes obvious that the relationship between the complex and the **elements** is bi-directional. A "revolt" of the elements- at time due to abuse of the higher complex can destroy the **whole**. For example, an alcoholic can destroy his liver...and as a result the liver destroys the alcoholic.

In P. CORNING's words: "...In short, there is **both upward and downward causation** in nature, and very often a **synthesis** of the two" (1998b, p. 14)

0687

CONTROL (Intrinsic) ^{2) - 4)}

"**Self-regulation** as distinguished from mere **regulation**" (St. BEER, 1968, p.262).

C. FRANÇOIS observes that we should find out how the system is naturally regulated before trying to control it... and this leads us to quite a tricky problem: we must evaluate how our controls would eventually impinge on the natural **regulators** (1978, p.4).

BEER observes that natural systems have "implicit controls" (p. 299) and **error** controlled **negative feedback**: "**equilibrium** is restored in the act to be lost" (p.353).

This is also the reason why in so many cases, authoritarian plans do not work in the long run and why human control frequently plays havoc with many natural systems, as for example with endemic malaria, agricultural pests, or so called "developing" countries economics and **social systems**.

0688

CONTROL MECHANISM ^{2) - 4)}

Any device that introduces **constraints** in the workings of a system.

The first step towards a control mechanism is given when two or more **elements** are becoming interactive in some definite way.

K. BOULDING gives the following detailed **description** of the control mechanism:

"A control mechanism always involves a number of **parts**. There must be: first a **receptor** of **information** (1) which picks up **information** regarding the **variable** to be controlled and, in particular, picks up **information** regarding **divergence** between the actual value of the **variable** and the **limits** of **tolerance**. In the simplest **mechanism**, all that is necessary is qualitative **information** about the sign of this **divergence**: the minimum **information** is that the **variable** is above the upper **limit** or below the lower **limit** of **tolerance**.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

"This **information** must be transmitted by a **communication system** (2)... to an executive or **decision maker** (3). The **function** of the executive is to transform the **information** received into instructions; it (or he) can be thought of as a kind of production **function**, receiving **information** by one **communications system** and sending out instructions over another (4).

"The instructions go to **effectors** (5) which carry out the instructions, and can produce an **effect**... "which is carried by another **communication system** (6) to the controlled **variable**" (1952, p.37).

At least two **elements** should be added to this description:

1 – In order to meet, or at least to register any divergence the **receptor** must be at the same time a **comparator**, or be connected with one. The **comparator** must compare the registered **input** with a previously incorporated **standard** and, possibly, with a register of former **states**. Only thus is any **information** created.

2 – Any **effector** needs the disposal of some spare **resources** to be used in order to be able to produce any **effect**. It should be for example a store of available **reserves** or a **source** of **energy**.

K. BOULDING gives the following example of control mechanism:

"Thus in the thermostatically controlled furnace, we have the thermostat (1) which registers **divergence** of the temperature from the tolerated **limits** (the upper and lower **limits** may in this case be contiguous). This **information** is transmitted by a wire (2) to the furnace control (3), which transforms the **information** into instructions sent by another wire(4) to the furnace (5), which is capable of transmitting the **effect** (heat) by a system of pipes and radiators (6) to the **environment** of the thermostat".

Thereafter BOULDING comments:

"The theory of the control mechanism has been developed in some detail by WIENER, and we need only mention some conclusions here. One is that a control mechanism always involves a **cyclical** movement of the controlled **variable**, the **amplitude** of the **cycle** being a **function** of the **sensitivity** of the mechanism. If the mechanism has pronounced **lags**, the corrective **effect** may only be brought into play after an extensive **divergence** of the controlled **variable** from the **norm** (or even after a spontaneous reversal of the **divergence**), and the correction may go too far before the counter-correction comes into play" (Ibid).

0689

CONTROL MECHANISMS (Problems in) ^{2) - 4)}

K. BOULDING states (1952) "In **organisations** of any degree of **complexity** there is not a single **variable** to be controlled but a large num-

ber of **variables**, and the **effectors** which affect one may also affect others. If each **variable** to be controlled has an isolated **effector** which is capable of controlling it, the multiplicity of **variables** presents no problem. We do not in general find this to be the case, however. **Action** which is taken to influence one **variable** will almost always have some effect on the others. If the **effectors** are sufficiently confused, the problem of control will become insoluble: in endeavoring to stabilize one **variable**, we inevitably unstabilize others; acute **cycles** may be set up and the **organization** may even desintegrate" (1952, p.389).

These effects appear clearly in the **systems dynamics models** created later on by J. FORRESTER. **Interactions** between **effectors**, **simultaneity** of effects in different **parts** of the **complex system** and **time lags (delays)** are very difficult to modelize satisfactorily... and to control.

As a result, in L. DOUGLAS KIEL words: "The traditional "engineering" view of public policy interventions intended to produce desired outcomes appear to better represent an abstract Newtonian vision, rather than the **uncertainty** of actual experience with such efforts. In short, the dynamic and **nonlinear** relationship between many **variables** in **social systems** reveals that policy decisions result in an enormity of unexpected outcomes" (1992, p.38).

0690

CONTROL (Multi-determined) ^{2) - 4)}

Most **behaviors** in natural **complex systems** are multi-determined, i.e. not controlled by only one device.

G. BATESON states: "Characteristically, every feature of the anatomy of an animal or plant and every detail of **behavior** is determined by a multitude of interacting factors at both the genetic and physiological **levels**; and, correspondingly, the **processes** of any ongoing **eco-system** are the outcome of multiple determination. Moreover, it is rather unusual to find that any feature of a biological system is at all directly determined by the need which it fulfils" (1973, p.476).

BATESON understands also that: "What is true of the species living together in a wood is also true of the groupings and sorts of people in a society, who are similarly in an uneasy balance of **dependency** and **competition**" (p.407).

Human engineering and **planning**, unfortunately, are much less sophisticated, not taking account of what lies directly in the path of their **purpose**. As a result, single-minded determination introduced in **processes** and controls frequently impairs **flexibility**, and even **survival** of the managed systems. Would be **controllers** should at least try to act prudently on **variables** that could prove "lethal".

Multi-determined control should seek to copy nature, where checks and counter-checks **interactions** tend to lead to better global **stability**.

0691

CONTROL (Negative) ^{2) - 4)}

"A **means** whereby courses are changed as to escape threats" (G. VICKERS, 1957, p.4).

VICKERS states: "Negative control reminds us that every system works within **limits** which cannot be passed without disaster. Some conditions must be preserved if the assembly is to hold together."

"... Thus all positive **goal seeking**, with the positive control which it involves, takes place within the **framework** of negative control, which ensures the continuance of the system" (p.4).

"... The control is designed to sense when the assembly is approaching the danger point; before this is reached, it remains inactive" (p.6).

Undoubtly, many contemporary problems in demographic, ecological and economic systems are a result of the general and obstinate ignorance of this **concept** of countervailing controls (enounced in 1957!).

0692

CONTROL OF and CONTROL FOR ^{1) - 2) - 4)}

Control, as a natural **process**, is non-volitive: it is basically the automatic result of reciprocal **constraints** between **elements**, **parts** or **whole** systems. It is obvious, for example, in **co-evolution**.

In contrast, human controls are mainly purposeful: the idea is to maintain a system within some specific **parameters**, or to the contrary, to enforce some new **parameters**, unfortunately sometimes arbitrary or even downright unsustainable, in order to change the system's **behavior** in a way desired by the **operator** and supposedly advantageous.

When inside and outside **contexts** (alike) are not duly taken into account, the results of volitive and purposeful control can easily be erratic, negative or even wholly disastrous (Ch. FRANÇOIS, 1983).

R. ESPEJO states: "... control is not a unilateral enforcement of **criteria** of **performance**, but rather the maintenance of a **dynamic stability** in the **interactions** among multiple viewpoints with reference to tacitly accepted, more or less flexible, **criteria** of **performance**" (1988, p.143).

A. RAPOPORT made the following somewhat controversial but quite significative comment: "... control of portions of the world become desirable not only for the **purpose** of exploiting the **environment** but also for the **purpose** of understanding it" (1972, p.18).

0693

CONTROL OR CONSTRAINT^{2) - 3)}

There is a subtle difference between both **concepts**. F. HEYLIGHEN writes: "... control is certainly a form of constraint. The basic difference seems to me that **control** requires a **controller**, that is to say a system separate from the system being controlled. In the **concept** of constraint it is not necessary (though it is possible) to situate the constraint in a separate system, the "constrainer". A constraint may be inherent in the system being constrained: the system may simply be the result of natural **selection**" (pers. comm.).

At least in **living systems** and in social ones, the system starts with its constraints, which give it its basic **autopoietic** characteristics.

As to control, HEYLIGHEN continues: "With control on the other hand, that control resides in a separate system, implies that there must be **channels of interaction** between **controller** and controlled. These **channels** will not be perfect. That means that **information** will not be transmitted completely or instantaneously. That implies that a variation of the controlled system cannot be exactly constrained: there will always be a **delay** between the start of the variation and the **reaction** of the **controller** constraining that variation. (Ibid).

In synthesis, control is by necessity somewhat imprecise and submitted to **time lags**. This means that any (human) **controller** should better be cautious and somewhat skeptical about the hoped for results.

0694

CONTROL (Positive)^{1) - 2) - 4)}

"A means whereby courses are chosen and kept so as to reach **goals**" (G. VICKERS, 1957, p.4).

Apart from the opposite **effects** of positive and negative controls, it should be noted that only humans seem able to choose positive control to reach their **goals**, at least at **macro- or megalevels of actions**.

Moreover they do not generally seem to be aware of the **accumulation** and potentially dangerous **effects** of repetitive **positive feedbacks**, used for positive control. This could very well lead to grave disasters now that mankind disposes of such powerful technical means.

0695

CONTROL (Programmed)⁴⁾

According to E. HERRSCHER, "there are two **modes of control in organization**: the programmed control and the **alert control**" (pers. comm., 2003)

He adds: "the programmed control consists of all the measurements, comparisons, indicators, audits, **observations**, reports and the like that have been established in order to assure an organization keeps on track and meets its **goals** as much as possible" (Ibid)

According to Herrscher, programmed control has its roots in seeing, a pre-active sense that responds "to our desire as to where to look, when to open and when to close (our eyes)" endowing us moreover with the capacity to focus our attention on specific **aims**.

On the contrary, the alert control is basically automatic, non specifically focused and always ready to react to **signals** of some imminent **emergency**.

→ **Perception; Perceptual field**

0696

CONTROL SPACE²⁾

The **set** of internal and external **parameters** of a system that are fixed by the experimenter (after R. THOM, 1993, p.39).

This set generates a global **configuration**, generally complex, i.e. divided into **regions** where one or another **attractor** dominates (Ibid).

0697

CONTROL (Symbolic)^{2) - 4)}

The collective maintenance of standard values of **meanings** in a culture.

Symbolic control is necessary to allow for the transgenerational transfer of **meanings** and general **knowledge**. It is obtained through **syntactic, semiotic and semantic rules**, generated through **conversation** among the participants of the culture and becomes stabilized by **autopoietic closure**. All kinds of schools, academies, etc..., as **transmitters** of all kinds of standardized **languages** are the most common symbolic controllers.

The idea was already clearly enounced by CONFUCIUS, when he insisted on the necessity of "correct designations" to maintain the "celestial order" in the chinese realms. He thus established the future cornerstone of imperial mandarinism, a typical symbolic control system.

0698

CONTROL SYSTEM (Characteristics of a)²⁾

According to O. JOHANSEN BERTOGLIO (1985, p.144-45) any control system needs the following characteristics:

- a **negative feedback**
- a **fixed point** of reference within a limited **vicinity**, wherein the **variable** must be kept
- a **repertory of states** which allows it to give an efficient **response** to any normal and specific **stimulus**

This last point is thus stated by G. PASK: "The amount of control (measured as a **variety**) depends upon the amount of **information** the **controller** gleans from the **environment**" (1961, p.53). This is equivalent to ASHBY's **Law of requisite variety**.

0699

CONTROL SYSTEM (in living systems)¹⁾²⁾⁵⁾

W. POWERS states: "Living **organisms** don't produce repeatable **actions**. They produce repeatable results" (1995, p.3)

He adds: "The theory of **control systems**, ... shows us how a relatively simple system can manage to produce reliable and repeatable results in an **environment** that has a large **component of unpredictability** - in other words, in the real world".

And "If you start with the idea that a behaving system controls outcomes or results rather than the actions that produce them, you can invent **control** theory from scratch. The first thing you realize is that this can't be done just by creating reproducible **actions**. The same action will have different results depending on what is going on in the environment. What you want is some basically simple way to produce a given result that doesn't depend on being able to predict exactly what action will be needed to produce it" (Ibid).

This is a very important comment, as it brings us back to the bedrock of **cybernetics**.

It also leads directly to HOLLAND's genetic adaptive plan through **rules** and to "**artificial life**" devices.

Finally, it is equivalent to VENDRYES' concept of **living systems**, able to control their own **relationship** with their environment, i.e. **autonomy**

0700

CONTROL (Time factor in)²⁾

G. VICKERS states: "Clearly problems of control are haunted by a complicated **time** factor. Each **signal** presents information derived from the past and initiates **action** which will take effect in the future. The effect of the **action**, more or less masked by other **variables**, will return for judgment at a still more remote point of **time**. Thus control is possible, even theoretically, only within **limits**; and these may present themselves as **thresholds** which are passed suddenly...

"The **span** between taking a **decision** and the comparison of its actual with its intended results ranges from seconds to years; and the longer it is, the more likely it becomes that no comparison will ever be possible, since so many **variables** will have contributed to affect the result" (1957, p.5).

This problem is closely related to **chaotic determinism**, in **complex systems**, prone to divergent **bifurcations**, whose theory was not yet developed when VICKERS wrote these lines (showing his impressive vision).

While his comment relates to volitive controls, it is no less evident that **long term** effects of natural controls are as difficult to predict... or more difficult still, because many of them are so ill understood.

0701

CONTROL (Time-Lag in) ²⁾

According to G. BATESON, in **homeostatic** systems: "... it is important that the highest system of control *lag behind* the **event** sequences in the peripheral **homeostatic circuit**" (1973, p.325).

This somewhat counter-intuitive view (also apparently contradictory to VICKERS' views), reflects the necessary **hierarchies** in **complex systems** controls. Basic **long-term regulations** must necessarily supersede **short-term fluctuations** of lesser **periods** and **amplitudes**, if they are to remain coherent and to keep in working order the general **organization** of the system.

0702

CONTROLLER ²⁾

"A natural or constructed assembly which interacts with its **environment** to bring about a particular **stability** called the "**goal**" or "**objective**" (G. PASK, 1960, p.49).

G. PASK explains: "Indeed, whenever there is a **stable system**, then, in principle, we can envisage a **subsystem** acting as the controller that maintains this **stability**" (Ibid).

Constructed controllers are generally based on quite simple **feedbacks**, but in natural systems a controller is frequently composed of a complex of countervailing **feedbacks**. In **Marxovian systems** or in **composite systems**, no specific controller can be found: the **control function**, as well as the "**goal**" or "**objective**", is diffuse in the whole system and is a result of statistical **interactions** among the **elements**, within however global limiting conditions.

As to human controllers (or would-be controllers), they should never forget Sir Francis BACON warning: "Nature, to be commanded, must be obeyed".

This implies a correct **understanding** of natural **feedbacks** and **regulations**, previously to any intervention.

0703

CONTROLLER (Adaptive) ^{1) - 2) - 4)}

A control device "which adapt the **decision rule** in order to achieve **stability** in a given **environment**" (G. PASK, 1961, p.61).

PASK contemplates two applications:

"In one the **environment** is unknown but **stationary**, when the adaptive controller is used to perform experiments which *could* have been done by its designer, to build a **model** and to determine an optimum **decision rule**. In the other, the **environment** is non-**stationary** and the controller *must* continually relearn about it" (Ibid).

In this last case the controller must become **hierarchically** organized. In order not to be overwhelmed by the **environment's** multiple and unpredictable variations, a **selector of inputs** equipped with a suitable **memory** must be incorporated in the global **control** system. As noted by PASK, this is the role played by a good secretary for a manager.

0704

CONTROLLER (Automatic) ²⁾

G. PASK states: "Automatic controllers receive perfect **information** about the system they control and have fixed **decision rules**, that determine their action" (1960, p.53).

This is satisfactory if and when there is no need for the system to modify too much its **behavior**. However, strong **environmental perturbations** may very well put the automatic controller out of use.

To quote PASK again: "The automatic controller is inert... It cannot prod its **environment**" (p.54).

0705

CONTROLLER (Imitative) ²⁾

G. PASK thus explains the imitative controller: "It comes into its own when *no signal*... is available although the **knowledge** of results **data** is intact... Since the controller has no direct evidence of the **state** of its **environment**, is cannot "learn to recognize" like the predictive devices. Instead the **machine** "prods" its **environment** by an **autonomous trial** making **behavior**. Then it learns which forms of **behavior** lead to the best results... the **machine learns to imitate**" (1961, p.59).

PASK signals that the term 'imitative' is due to D. Mac KAY (1956).

0706

CONTROLLER (Overall) ²⁾

A controller that makes trial **adjustments** and chooses whichever of these gives the greatest positive increment of a defined **reward variable**. (Adapted from G. PASK, 1962, p.65).

"Overall controllers of this kind are often called "hill climbers" or **optimizers**" (Ibid).

However, in a complex setting, wherein different unequal **optima** are separated by suboptimal **zones**, an **iterative refinement algorithm** may be needed in order to reach the true **optimum**.

0707

CONTROLLER (Predictive) ²⁾

A controller that can learn to recognize some **states** of the system or the **environment**.

The predictive controller can at least "blow the whistle" and, in some cases, take anticipative measures to maintain the **stability** of the system. Therefore, it must be endowed with specific **decision rules**, preadapted to a **variety** of possibilities.

→ **Behavior (Anticipatory)**

0708

CONTROLLERS (Hierarchies of) ^{1) - 2)}

G. PASK describes such a hierarchy as follows: "The lowest **level** controller imitates its **environment**, learning that *a* is more likely than *b*. The second **level** learns sequences, *a* then *b*, or *b* then *a*. The next **level** learns about and imitates *sequences as a whole*, not *a* or *b* as such, and further **levels** learn about *categories of sequences*. In other words, "sequences" and "categories of sequences" become represented by **symbols** at different **levels** of discourse and the **artifact** performs a **non-trivial abstraction**" (1962, p.66).

From the viewpoint of the nature of **abstraction**, this should be compared with KORZYBSKI's **structural differential**. (1950).

From the viewpoint of biological or human **organization**, it helps understand how a differential power to generalize leads unavoidably to the shaping of **hierarchies**.

According to St. KATZ: "The **hierarchical** arrangement as a whole is designed to carry out the highest **order goals** of the **organism**; lower **order goals** are simply **means** to this highest end" (1976, p.45).

0709

CONVERGENCE ^{1) - 2) - 4)}

The move toward a predefined result or **goal**.

Seeking convergence is very important in the **management of concrete systems** and specially in **planning** activities with a great number of intermediate stages, as for instance investment programs, construction of industrial complexes, **development** programs of any kind, research programs, etc... As shown by St. BEER, the successive **interactions** between the **elements** and/or **subsystems** can generally be modeled by a **flow graph** representing the "ramified system" (1966, Ch.9).

Convergence can be spontaneous, or not, as **complex systems** easily show **chaotic behavior**. A **graph network** flowing through the **time** dimension can be made less stochastic, but then only under the condition of the presence

of an efficient **control** tending to diminish **indeterminacy** through the introduction of **feedbacked information**.

Failures to do so may become quite costly. BEER gives the following example: "It could thus happen, by a concatenation of... circumstances, that a two weeks delay encountered within the construction **program** itself might result (let us say) in a six-month postponement of the final completion. This outcome would be thanks to the ramification of the system concerned: it begins to act as an *amplifier of delays*" (p.192).

E. LASZLO equates convergence with the formation of **catalytic hypercycles**: "The outcome of convergence is a higher-level system that selectively disregards many details of the **dynamics** of its **subsystems** and imposes an internal **constraint** that forces the **subsystems** into a collective **mode** of functioning" (1987, p.34).

K. KRIPPENDORFF indicates the following social meaning for convergence: "The convergence **model** of **communication** postulates that as people communicate with each other they become more similar in **knowledge** and in attitudes and thus converge to form a **homogeneous distribution**" (1986, p.18). It should possibly be better to merely speak of a "*more homogeneous distribution*". Moreover, convergence can be obtained only through a well organized **conversation**.

0710

CONVERGENCE AND DIVERGENCE IN THE BRAIN²⁾⁵⁾

J. ECCLES sums up these two basic features in **neuron networks**, as follows

"*Principle of convergence*: the feature of the **nervous system** in which many nerve **cells** project to a single **neuron**

"*Principle of divergence*: the feature of the nervous system in which one neuron branches to be distributed widely to other neurons"(1977, p. 241)

The **complementary** of convergence and divergence transforms the neuron network into a gigantic **graph** potentially and conditionally connected in a practically infinite number of ways.

Both principles taken together are obviously a general condition for any network, i.e. for any social **communication net**. It is suggestive that:

- either we model our social exchanges in accordance with our **neural organization**
- or that our neural organization clearly allows us to create mental means conducive to **sociality**

0711

CONVERSATION^{1) - 4)}

Interaction between two or more participants.

This concept has been introduced by G. PASK, who states: "A conversation takes place within a contractual **framework**; and *this* rather than a **stimulus/response** system, is argued to be the *least* meaningful experimental **situation**. In a conversation it is possible to observe *psychological events*; in other **situations** it is *not*. **Observation** consists in recording and interpreting **dialogue** between the participant individuals. Experimental **regulation**, **parameter change**, etc., is achieved by instructing one *participant* to execute a prescribed **heuristic**. It is crucial however, that the participant does so, and not the **observer** and that he retains the partiality as well as the liberty of a participant. Hence the **heuristic** is not to be equated with an **algorithm**" (1972, p.3).

G. McINTYRE BOYD states: "PASK's p-individuals can interact at five **levels**:

1. - the **level** of direct **action** in a shared **space**
2. - the **level** of simply naming each **action** taken (in the **protolanguage L**)
3. - the level of conveying explanations of these **actions**
4. - the **level** of explanations of the explanations - the top **level** of "teachback" (also in L)
5. - the **level** of negotiation of the engagement to converse and specification of the scope of discourse and other **rules** (This is the **level** of the **metalanguage L**") (1993, p.121).

By its very nature conversation is thus circular, or better, cyclical, as observed by R. GLANVILLE (1993, p.52).

Conversation generally leads to **consensus** and the common acceptance of some "**truth**", but this may sometimes happen after protracted debate and even **conflict**.

As stated by F. ROBB: "... agreed **meanings** are formed by negotiation or compulsion... The formation of **meanings**, in this **context**, is taken to include making **distinctions** between **objects** in experience (or in thought) and their ground, forming mental **models** and making valuations about **situations** and **objects**; so that 'good' is discriminated from 'bad', 'desirable' from 'undesirable', and 'true' from 'false'... Conversations may also negotiate what constitute valid ways of making these **distinctions** and of establishing these **values**" (1993, p.1).

Finally, in D. GREGORY's words: "Conversation theory is nothing more - and nothing less - than the attempt to model the way in which we manipulate our **metaphorical** systems to construct shared **meaning** and thereby, come to agree with one another over what we understand" (1993, p.71).

Thus, as stated by R. GLANVILLE: "Conversation is not a linguistic device: **language** is a conversational device"(2001, p. 147)

However, behind the **mechanisms** and the **cybernetics** of conversation, there is a psychological aspect, thus described by K. BAUSCH: (Conversation implies) "listening without judging, without a predetermined personal agenda, and with a willingness to suspend one's own **assumptions**. True dialogue is thinking together, in BÖHM's words, so that new **meaning** may emerge. conversation is the main vehicle for collaborative **learning** and in **design processes**, it is the process that makes images of the future shared and public"(pers. comm.)

The relations with **constructivism** and with mental **autopoiesis** are obvious.

0712

CONVERSATIONAL DOMAIN¹⁾

The **set** of topics debated by participants in a **conversation**.

This **concept** has been introduced by G. PASK, according to whom the "... individuals... participate in a **process** of **understanding**, retaining and **learning** that goes on" (1972, p.3).

Eventually, **consensus** may be reached or reformed about the **meanings** within the conversational domain, or some shift toward another domain may take place.

0713

CONVERSATION (Reflective)

→ **Stigmergy**

0714

CONVERTER^{1) - 2)}

"The **subsystem** which changes certain **inputs** to the system into forms more useful for the special **process** of that particular system" (J.G. MILLER, 1978, p.3).

The converter is one of MILLER's **20 critical subsystems**. It transforms **matter** and **energy inputs**. Any **complex system** may have many different specialized converters.

0715

COOPERATION¹⁾

N. TINBERGEN wrote already in 1965 in his "Social Behavior in Animals" that the result of cooperation of individuals is continually tested and checked and thus the group determines ultimately, through its **efficiency**, the properties of the individual.

It is now well understood that cooperation is a special aspect of **interaction** within **networks** in a specific **environment**. Each individual or **element** is communicating with a number of other ones within the group or the species or, in case of men, the **organizations** in which it participates.

In many cases, but not all, it is also directly related to some specific part of the **environment** and serves as a **transmitter** of the **environment** reactions to its **activity** and, in some

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

cases, to the activities of other members of the **group**. It (or she/he) may then, willingly or not, have to pay for some ill adjusted proper or groupal **behavior**.

0716

COOPERATION as an evolutive process^{1) - 2)}

F. HEYLIGHEN describes as follows the complete evolutionary sequence leading from **competition** to cooperation: "... **competition**, **communication**, stable **interaction patterns**, internal **models** of **patterns**, shared **models**, shared **replicators**, cooperation promoted by shared **replicators**, **integration** with the shared **replicators** as coordinators" (1992b, p.25)

This is clearly a **cybernetic model** which includes for example G. PASK's "**conversation**", with its reciprocal **accomodation process** (**consensus** – von FOERSTER **cybernetics of second order**), GABOR'S and Mac KAY'S "**log-on**", shaping of a **hierarchy** through the appearance of a **regulator**.

And, in E.von GLASERSFELD's words: "... the **situation** of reciprocal instrumentality has the potential of developing into collaboration" (1988, p.51).

0717

COOPERATIVE STRUCTURE^{1) - 2)}

Cooperative structures are observed in all social animals. They are also now researched within the frame of A.I. and are acquiring a very general **meaning**, as a **model** of **self-organization** of complex **wholes** by reciprocally regulating **interactions** between **elements** formerly independent from each others. This is basically a **bottom-up phenomenon**, governed by **generative rules**, closely related to **cellular automata**.

Construction of cooperative structures is also **recursive** and seems even to have been one of the most important factors in general **evolution**, as a stepping stone to ever higher **levels** of **sociality**, as shown by C. BRESCH (1977, 1987).

More recently, a number of researchers started to study more elaborated **models** of cooperative structures, mainly through the new discipline called **Artificial Life** (A.L.). For detailed information see, under others, C. LANGTON (Ed.), 1989 and the SIGART Collection on Integrated Cognitive Architecture (1991).

0718

CO-OPERATIVE SYSTEMS

→ **Systems (Cooperative)**

0719

COOPERATIVITY²⁾

According to V. ROWLAND, cooperativity is a typical property of **elements** in **networks**: "... the property of neurons interacting with their immediate neighbors and generating by this means, sudden **transitions** from noncooperative to cooperative **dynamics**" (1976, p.123).

ROWLAND traces cooperativity back to atomic, molecular and magnetic **phenomena**.

Cooperativity, in this sense, is probably the initial step toward **sociality**. It is related to **percolation** and the unstable **behavior** of **composite systems**.

0720

COORDINATION^{1) - 2) - 4)}

The **synergetic** functioning of the **subsystems** within a system.

General coordination depends on some **elements** being widely connected into the different **parts** of the system, in such a way as to be able among them to collect the most complete and recent **information** about the system as a **whole** and use it to avoid incompatibilities between **processes**.

This is the case for instance of some neurons whose axons diverge into the whole **brain** (J.P. CHANGEUX, 1992, p.710), or of the national political and administrative **subsystem** within a country.

Coordination tends to be, but is not necessarily automatic, specially in **human systems**.

M.D. MESAROVIC, D. MACKO and Y. TAKAHARA state: "To coordinate the **subsystems** is to influence them so that they function or act harmoniously, such as one would coordinate the **activities** of individuals or **groups** within an **organization**. To make this idea of coordination operational, one has to define more explicitly what is meant by "acting harmoniously". In general, "this is done in reference to a **goal** or **objective**, so that the **whole** achieves the stated **objective**".

"Coordination is the task of the supremal **control** system, in which it attempts to cause a harmonious functioning of the infimal **control** system.

"The success of the supremal in its task of coordination is judged relative to a given overall **goal** of the **two-level system**. Since the infimal **control systems** operate so as to achieve their own individual **goals**, a **conflict** generally develops among them and results in a prescribed overall **goal** most likely not being attained. The task of a coordinator is precisely aimed at reducing the consequences of such an intra-organizational **conflict**, if not to eliminate it altogether" (1970, p.93-4).

The same authors distinguish the following types of coordination:

- **interactive – predictive**: "The supremal unit specifies the **interface input**, and the infimal units proceed to solve their local **decision** problems on the assumption that the **interface input** will be exactly as predicted by the supremal unit"
 - **interactive – estimative**: "The supremal unit specifies a range of values for the **interface inputs**, and the infimal units treat the **interface inputs** as **disturbances** which can assume any value in the given **range**"
 - **interactive – decoupling**: "The infimal units treat the **interface input** as an additional **decision variable**; they solve their **decision** problems as if the **value** of the **interface input** could be chosen at will"
 - **load-type**: "The infimal units recognize the existence of other **decision** units on the same **level**; the supremal unit provides the infimal units with a **model** of the **relationship** between its **action** and the **response of the system**"
 - **coalition-type**: "The infimal units recognize the existence of other **decision** units on the same **level**; the supremal unit specifies what kind of **communications** are allowed between them. This leads to a coalition or competitive (**game theoretic type**) **relationship** between the infimal units" (1970, p.59-60).
- All in all these 1970 comments mostly reflect a quite traditional **top-down** authoritarian view of coordination. The **heterarchical** or **holographic** view of **organizations** which appeared more recently suggests that coordination is notably furthered by reciprocal **understanding** among **subsystems**.

Coordination is also obvious in natural systems – biological or ecological – and it is by no means evident that it is done in an exclusively **hierarchical** way.

0721

COORIENTATION^{1) - 2) - 4)}

The **behavior** of **elements** trying to harmonize their **interactions** or **relationships** in conformity with the global ordering of the system they are **part** of.

This implies the necessity to perceive – at least up to a point – this global ordering. Coorientation is thus an important aspect of **autopoietic catalytic cycles** (M. EIGEN). In animal **sociosystems**, the needed **perception** is biochemical (bees, ants) or visual (fish shoals) or auditive (cetaceans). In human systems, the main coorientation **mechanisms** are **values** and **norms**, shared mainly through spoken or bodily language.

Coorientation derives ultimately into a global **constraint**, or **order parameter**, that **synchronizes** the collective **behavior**.

0722

COPRODUCER²⁾

A **producer subsystem** that associates with one or more other **producer subsystems** to form some energetic, material or informative **association** needed by the system.

This is *not* one of J. MILLER's **20 critical subsystems**. Coproduction, however, is quite frequently observed in systems.

0723

CORE (Frozen)²⁾

"A connected mesh of **elements** that are effectively locked into either an active or inactive **state**" (1991, p.67)

According to St. KAUFFMAN, who introduces this **model**: "The frozen core creates interlinked walls of **constancy** that *percolate* or grow across the entire system. As a result, the system is partitioned into an unchanging frozen core and islands of changing **elements**. These islands are functionally isolated: **changes** in the activities of one island cannot propagate through the frozen core to other islands. The system as a whole becomes orderly because **changes** in its **behavior** must remain small and local. Low **connectivity** is therefore a sufficient condition for orderly **behavior** to arise in disordered **switching** systems".

Obviously, KAUFFMAN rediscovered ASHBY's **understanding** of the nature of **poorly or richly joined systems** and the importance of **constraints**.

Frozen cores may also explain the origin of **structures** and is reminiscent of LAVILLE's concept of permanent **whirls**, of D. Mc NEIL's **model** of **toroid**, and even possibly of d'ARCY THOMPSON's discoveries about the evolution of **forms**.

0724

CORPUSCULAR ADDITIVITY IN SYSTEMS²⁾

I.V. BLAUBERG, V.N. SADOVSKY and E.G. YUDIN observe (after A. MALINOWSKY) that, in **living systems** "In proceeding from the lower **levels**, bordering on molecular biology, to the higher ones (those of the **cell**, the **tissue**, the **organism**, the **species**, etc) a regular alternation of... two types of **organization** may be observed: paired chromosomes (corpuscular property), **complementarity** of the nucleus and the cell (rigid **relation**), **cells** of the same tissue (corpuscular property), mutual **complementarity** of tissues, multiple **organs** or their **parts** (corpuscular property), **relations** between systems of **organs** (rigid **relations**), individuals of the same sex (corpuscular properties), **complementarity** of sexes (rigid **relations**), etc." (1977, p.217).

0725

CORRELATION²⁾

"The **relation** between two series such as for every **part** of one series there is a corresponding **part** in the other series and no **part** of either series is without a corresponding **part** in the other".

J. FEIBLEMAN and J.W. FRIEND add to their definition that the correlation can be: "one-many; one-one; many-one, many-many" (1969, p.33). Any **relation** implies one or another of these types of correlation.

The existence of correlations constitutes the base for **homeomorphies** and **isomorphies**. For example, any **integrated system** possesses a **boundary** (its contact **subsystem** with its **environment**) and, in the above **meaning**, there is a **functional** and **structural** correlation between the **boundary** and some internal **subsystems** as well as with some **parts** of the **environment**. In the realm of **models**, **isomorphies** signal correlations between similar aspects of otherwise different systems.

Correlation is also understood as the permanence of **interrelations** within a system, a condition basic for its **stability**, i.e. a **co-variance** of some significant **processes**. S. DINER writes accordingly: "The reduction of correlation between more and more distant points on a **trajectory** is in fact the fundamental mark of the appearance of a **random** character. This is basically **deterministic chaos**" (1992, p.351). De-correlation implies thus a kind of **memory** loss of its **initial conditions** by the system.

There is a **critical distance** for correlation, which depends on the **field's parameters**. This implies that **interactions** become negligible beyond some specific **limit** – which does not necessarily means inexistant, if D. BOHM's **implicate order** idea is accepted.

Correlations frequently are significant **clues** for the study of systems.

Correlations can be causal, complementary, parallel or reciprocal. In such cases, they are generally obvious...but not necessarily very clearly and well understood. Neither are their **evolution** in **time** precisely established. **Growth phenomena** for instance can be of quite different kinds, reflecting diverse types of correlations.

A particular, but very interesting case is the **association** that can be created, or at least supposed or attempted, between two statistical series related to different **sequences of events**.

A certain **parallelism** or **similarity** between such series can be significant, but not necessarily so: the correlation between smoking and lungs cancer was widely and protractedly discussed before the **cause-effect** relation became well established and generally recognized.

In any case correlations between two **processes** can be a consequence of a common causal **link** with a third process.

The study of correlations is a quite developed part of statistical analysis and includes **frequency distribution**, **time** series analysis, **linear** and **non linear trends**, theory of sampling, **graphs**, **matrixes** and tables, coefficients of **reliability**, etc.

Correlation as a forecasting tool

Correlation in **time** with some seemingly or possibly related developments in technically connected fields is an important **forecasting** tool. For example, the use of micro-electronics in the construction of radio sets was a significant technical novelty whose impact on the radio sets industry could be more or less predicted by perceptive industrialists in the field... and ruin the business of the others.

I.G. BLOOR states: "The correlation technique attempts to put a value on the strength of any **relationship** producing a so-called "correlation coefficient" in the range of +1 to -1. The stronger correlation is +1." (1987, p.7). When practically possible, correlation calculation would be very useful.

0726

CORRELATION AND CAUSALITY¹⁾³⁾

A statistical correspondance between two or various series of **observations** related to the **behavior** of the same or various entities can be fortuitous.

Accordingly, correlation does not necessarily imply a causal **link**.

Such a **link** may be established only when:

- one **phenomenon** can normally be explained by the preceeding occurrence of the other
- both observed **phenomena** can be explained as different consequences of another one

Anyhow, correlations should in many cases be considered as an indication of a possible causal **relationship** and investigated as such.

0727

CORRELATION DEVICE^{1) - 2)}

As early as 1924, A. LOTKA observed that, what he was calling "natural mobile transformers", i.e. animals, could be **autokinetic** only as much as they were able to adjust their **behavior** to the variable circumstances of their **environment**. In order to do this, they need an internal device able to represent to themselves any variation of their relation with their **environment**. LOTKA introduced the term "**depictor**", to designate such a device and described it as follows: "The depictors include first the **Receptors** or Organs of Special Sense (eyes, ears, nose, etc...); and second the **Elaborators**, whose **function** is to combine and further elaborate the crude **information** furnished by the senses. The physical location and **structure** and mode of **operation** of the **elaborators**

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

is much less obvious than that of the **receptors**. In fact, we ordinarily recognize them rather as faculties (**Memory**, Reason) than as **organs**.

"Another set of **organs** and faculties, the **Adjustors**, determine the particular reactions, the **behavior** of the **organism**, in the light of the **information** brought in by the **receptors** and further elaborated by the **elaborators**...

"The last step, **action**, commonly involves the use of members, or **motor organs**, **effectors**, such as wings, feet, hands, etc... In complicated cases, as in human **behavior**, the **elaborators** may also play an important role in the **effector** step of the **process** by which motion is correlated to **environment**, **behavior** adapted to circumstances" (1956, p.340)

In this case, **prediction** and **planning** do appear and a unique and immediate **behavior** is replaced by a sequence of planned projected **behaviors**, oriented towards the future and with specified schedule. Such a device is obviously indispensable in any **artificial intelligent system**, endowed with **autonomous behavior**. LOTKA himself described such an **automaton** (a mechanical walking beetle).

The **analogy** of the correlation device with some of J.G. MILLER's critical **subsystems** is striking.

0728

CORRELATION DIMENSION ²⁾

"A number that measures the degree to which the system's **attractor** "fills up" the **space of states**" (J. CASTI, 1994, p.101).

CASTI states: "The correlation dimension weights the points on the **attractor** according to how frequently they are visited... A telltale **sign of chaos** is when the correlation dimension turns to have a noninteger value much greater than 1" (Ibid).

Thus, in such a case, fractionary correlation implies **deterministic randomness**.

See: **FEIGENBAUM's number**.

0729

CORRELATION (Directive) ²⁾

Permanent or at least recurrent **interrelation** entailing a reciprocal **control** between two or more **functions** in a system, such as their interconnected action converges toward some coherent **behavior**.

G. SOMMERHOFF defines this concept in a formalized way (1969, p.174-5) and proposes it as a suitable alternative to the so-called "**Goal-directness**", which has finalists overtones.

Directive correlations undergo **reinforcements** with **time**. They are the base of all types of **adaptation**, on **short**, **medium** or **long term** (p.177-81). They seem closely linked with the concepts of **self-regulation**, **autopoiesis**, **organizational closure** and **hypercycle**.

G. SOMMERHOFF emphasizes moreover that "Every directive correlation has a precise signification only in relation to the **historical** period of reference" (p.187). The most robust directive correlations are those which correspond to the oldest and most confirmed **adaptations**.

0730

CORRELATION LENGTH ²⁾

Maximal propagation distance of the effect of some **disturbance** within a **net** (after K. WILSON, 1989, p.92).

This maximal distance plays an important role in **composite systems**, as it commands the **percolation phenomena**.

WILSON observes that: "Regions separated by a distance superior to the correlation length are independent" (Ibid).

The correlation length is variable according to the **state** of the system. It is major in strongly connected systems and less so in weakly connected ones.

This is verified for example in the disappearance of magnetization at some distinct temperature (CURIE's temperature) (Ibid), or in the spontaneous extinction of a forest fire inside of the already burnt down zone or, again, in the extinction of a pandemy when the number of victims exceeds some defined **limit**.

WILSON points out that: "That which is most significant when the correlation length increases is that the small variations do not disappear when variations of a greater **size** expand: they merely become a finer **structure**, superposed to the larger scale **structure**" (Ibid).

As a result, systems of this type show a **fractal structure** and may manifest local **behaviors** at variance with the global one.

0731

CORRELATION (Potential directive) ^{1) - 2)}

Aptitude for reciprocal **control interactions**, which are activated only when certain **environmental variations** make it necessary.

This type of correlation appears for example when a hungry animal reaches a state of alertness and starts to run after a prey. G. SOMMERHOFF writes, moreover: "An animal in a state of alertness is not just in a state of potential **activity**, but of potential activity of a *certain kind*" (1969, p.192).

According to SOMMERHOFF the concept is no less important in order to explain search or impulsive **behavior**, or **social integration**. In this last case, he emphasizes the fact that social **cohesion** refers not only to what **components** are doing in general, but to what they should do if some specific situation should happen. He gives the following example: "A patriot is not a patriot so much by virtue of what he

does at every moment of his daily routine, but by virtue of what he would do in certain special contingencies, as in a case of a national emergency" (p.193).

0732

CORRELATION (Spurious) ¹⁾

According to some early critics of G.S.T., most **analogies** lead only to senseless comparisons between widely different entities (R.C. BUCK, 1956).

Of course, **analogy** is merely a *weak heuristic* tool... but is it better than none. Moreover, an **analogy** may lead to an **homology** or **isomorphism**, i.e. a more formalized **model** that can be applied to different **objects** of study.

BERTALANFFY writes: "Buck's criticism is, in principle, the same as if one would criticize NEWTON's law because it draws a loose "**analogy**" between apples, planets, ebb and tide and many other entities; or if one would declare the theory of probability meaningless because it is concerned with the "**analogy**" of games of dice, mortality statistics, molecules in a gas, the **distribution** of hereditary characteristics, and a host of other **phenomena**" (1962, p.9).

0733

CORRELATIONS (Complex) ²⁾

Interferences variable in **time** between multiple **elements** or **factors**.

This kind of correlations is frequent in **ecosystems**, specially in perturbed ones.

A **population** crash of some **parasitic** or predator species may transform definitively the general more or less **cyclical dynamics** of the system and permanently change the **relations** of **equilibrium** among its **components**, some of which could even disappear.

It seems possible that a factor like technological acceleration could produce this type of **transformation** between specialized groups in human societies, some of them being eliminated and others emerging or becoming dominant.

0734

CORRELATIONS (HIERARCHIES of directive) ²⁾

G. SOMMERHOFF introduced this concept in order to account for directive correlations of directive correlations.

He wrote: "Sometimes the **goal** of a directive correlation at one **level** of the **hierarchy** is a correlated **variable** in a directive correlation at the next higher **level**" (1969, p.189)

General correlations of this type allow the **integration** of the system as a specific **whole**, whose most general **goal** is its own **survival** as such.

Hierarchies of directive correlations do result of **learning processes**, but then only on the basis of potentialities acquired by the system at the moment of its **autogenesis**.

0735

CORRESPONDENCE PRINCIPLE³⁾

"Any new theory should reduce to the old theory for those cases in which the old theory is known to hold" (St. UMPLEBY, 1979, p.11).

UMPLEBY attributes the principle to H.von FOERSTER. He however adds: "This principle assumes that science grows somewhat like concentric circles" (Ibid).

This **phenomenon** is a quite general feature of science evolution during the 20th Century and finds its most general explanation in **GÖDEL's theorem**.

0736

COST^{1) - 2) - 4)}

"... the potential **energy flow** into heat necessary for a **process**" (1971, p.187).

This somewhat surprising but quite universal systemic generalization of the **concept** of cost by H. ODUM is in perfect accordance with the **2nd law of thermodynamics**, which controls all cosmic (and human) activities.

The practical lack of a systemic concept of cost is one of the most serious hidden problem of our time, since **long term** or indirect costs remain hidden due to ignorance or malicious concealment.

Even ODUM proposal should be extended, since any **process** is part of a system's **activity**, which in turn takes place in an **environment** whose correct and complete **description**, and **evaluation** is seldom considered.

An excellent example is the "cost" of oil, a non-renewable **resource**. Is it the cost of its discovery, extraction, transport and refining? Or should it include the **environmental** costs of its use? Or should it take in account the very difficulty to calculate costs of its replacement as a non-renewable **resource**?

For the concept of benefit per unit cost, see **Foraging theory**.

0737

COUNTER-INTUITIVE BEHAVIOR^{1) - 3)}

R. ROSEN states: "... in general the **behavior** of **complex systems** is "counter-intuitive": ... large systems generally act in quite a different manner than is expected from "common sense" considerations" (1974, p.94).

The same point has been made by J. FORRESTER in relation to his **Systems Dynamics**.

The main reason is given as follows by ROSEN: "Basically, it is because such intuitions we have about systems are drawn from systems which are in some sense "simple" (Ibid).

Complexity, as a result of numerous intertwined **interrelations**, is quite difficult to grasp entirely and unsound simplifications are normal, even in trained persons. **Deterministic chaos** theory has recently revealed a new and surprising dimension of unsuspected **behavior** of **complex systems**.

Ignorance of counter-intuitive behavior leads easily to inappropriate policies. Some initiative taken in order to alleviate a critical **process** in a system, while seemingly logical in an intuitive way, may actually turn the **situation** still more critical in the future. R. ARNOTT and K. SMALL give the following example: "Expanding road capacity creates its own demand, a phenomenon known as the Pigou-Knight-Downs Paradox... Expanding capacity *only attracts more users*" (1994, p.448).

This merely fuels a **positive feedback**, at least until basic **resources** are totally used up or sky-rocketing **costs** block the **positive feedback**.

0738

COUPLING (De-)²⁾

Mode of protection from **environmental disturbances** by way of an isolating device.

This is not a **regulation** but merely an unilateral defence against some specific kind of **environmental disturbance**. An example is the shell of a tortoise.

Of course, this type of device prevents any **interaction** with the **environment**, included some that could be useful. The decoupling capacity is generally a property of the **boundary** of the system.

0739

COUPLING (Degrees of)²⁾

J.C. LUGAN distinguishes three main types of coupling between **elements**:

"1. To a value of an **element a** corresponds one and only one value of the **element b**. We say that *a* and *b* are strongly coupled;

"2. To one constant value of the **element a** corresponds a variation of **element b** in between two **thresholds** x and y. Outside of these **limits**, the value of *a* changes. We say that the coupling is **flexible**.

"3. To a value of *a*, various or even any value of *b* correspond. We say that the coupling is weak or inexistent.

"Thus, a system is strongly **integrated** when all of its **elements** are strongly coupled. Of course, in a **set**, it may be possible to distinguish more or less **autonomous subsets** whose **elements** or **variables** are strongly coupled. This leads to the notion of **subsystem**" (1993, p.28).

0740

COUPLING (Excessive)^{1) - 2)}

Saturation of all the possible **connections** in a system.

This notion is stated by J. MELESE (1972).

A completely connected system is by necessity, totally rigid. It becomes unable to react to any **disturbance** of a new type: it cannot anymore learn or adapt.

J.L. LEMOIGNE shows that, to remain **adaptable**, the system should not be *totally* adapted. He quotes MELESE, who wrote: "**Adaptation** requires **stability**... or more precisely the presence of enough zones of **stability**, to allow for the search of local **adjustments**" (1977, p.158).

MELESE's zones of stability seem to be equivalent to KAUFFMAN's **frozen cores**.

Adaptability supposes experimentation, which implies the necessity to possess a (considerable) **variety** of potential **connections**.

→ **Frozen Core**

0741

COUPLING (Loose)^{1) - 2)}

A condition in systems by which **change** in one **part** does not generate necessary any **predictable changes** in all others.

Loose coupling may imply:

- a **discontinuous**, on-and-off **interrelation** between some **elements**
- the outright absence of **connexions** between some **elements**
- **connexions** triggered only when some **threshold of activity** is crossed.

Applying this idea to **organizations**, J.A. JOHANNESSEN and A. HAUAN make the following complementary statements:

"In order to change a tightly coupled system, a device must be implemented that makes the **parts** of the system where **changes** are most wanted more loosely coupled, thus creating "shock waves" that stir up the **patterns** of relations" (1992, p.186).

0742

COUPLING (Structural)¹⁾³⁾

The recurrent and typical **interactions** between a biological system and its **environment**.

Structural coupling may imply two different types of relationships. F. CAPRA explains this in the following way: "Kicking a stone and kicking a dog are two different stories, as G. BATESON was fond of pointing out. The stone will *react* to the kick according to a **linear chain** of **cause** and **effect**. Its **behavior** can be calculated by applying the basic laws of Newtonian mechanics. The dog will *respond* with structural **changes** according to its own nature and (**non-linear**) **pattern** of **organization**. The resulting behavior is generally unpredictable" (1997, p. 219).

This means that the dog *may* growl, bite, moan, crouch, or run.

This possibility of various alternative behaviors, present both in dog and man introduces the possibility of different **chains of events** in the ongoing **interactions** between both...in an ongoing **process**. Among human beings this opens the way for example to "**conversation**" in Pask's sense.

Accordingly, in the **autopoiesis theory** of the **observer**, the relation of the **organism** with its **environment** is seen as an endless sequence of **experiences** made by the organism, not in terms of **stimuli** from an objective external **reality** registered merely in a passive way, but as a kind of reactive internal reorganization within the limits of already existing **structures**. Whatever these may be in terms of **brain** histology and/or **neuronal connections**, it is clear that each individual constructs his/her own **frames of references**, from his/her birth on (be it the technique of bicycling, or the **rules of a language**).

As a result of this **structural coupling**, these internal **frames of references** are internally re-organized, but still as **self-reproducing structures**.

Structural coupling is specially significant in conversation between observing systems. In MATURANA and VARELA's terms (as quoted by S. BRIER - 1995, p.7): "In the coupling, the autopoietic conduct of an **organism A** becomes a source of deformation for an organism B, and the compensatory behavior of organism B, in turn, as a source of deformation for organism A, whose compensating behavior acts again as a source of deformation of B, and so on recursively until the coupling is interrupted".

Structural coupling is now incorporated in **systemic familiar therapy**. It could even possibly be applied to economic and **social systems**. Even binary stars systems are structurally coupled!

→ **Constructivism; Eigen behavior; Eigen values; "Reality" (Riddle of); Recursivity; Structural coupling**

0743

COUPLINGS between two elements²⁾

The following figure, as drawn by George KLIR (1969, p.155) shows "All possible kinds of couplings in the vector form between two **elements**" (on one type of **flow** only).

The figure shows the astounding **variety** of **processes**, most of them interactive, that can be obtained from very simple **connections** between the absolute minimum of intervening **elements**.

It also shows all that is lost by severing these **connections** by any **reductionist operation**.

see figure right

0744

CO-VARIANCE

→ **Variance (Co-)**

0745

COVERING-LAW MODEL³⁾

J. BRYANT writes: The most widely-held theory of scientific **explanation** among philosophy of science is the so-called "C-L model". which holds that a scientific explanation has the form of a **set of conditions** statements C and a set of universal laws L, which together logically implies a so-called "**explanation statement**" P, where P describes the fact to be explained, and where the fact that P is deduced from C and L constitutes the explanation" (p. 29, 1991)

Such a formulation implies a **belief in determinism**. However contemporary widened and variagated concepts of determinism seem to

weaken the general concept of the covering-law model.

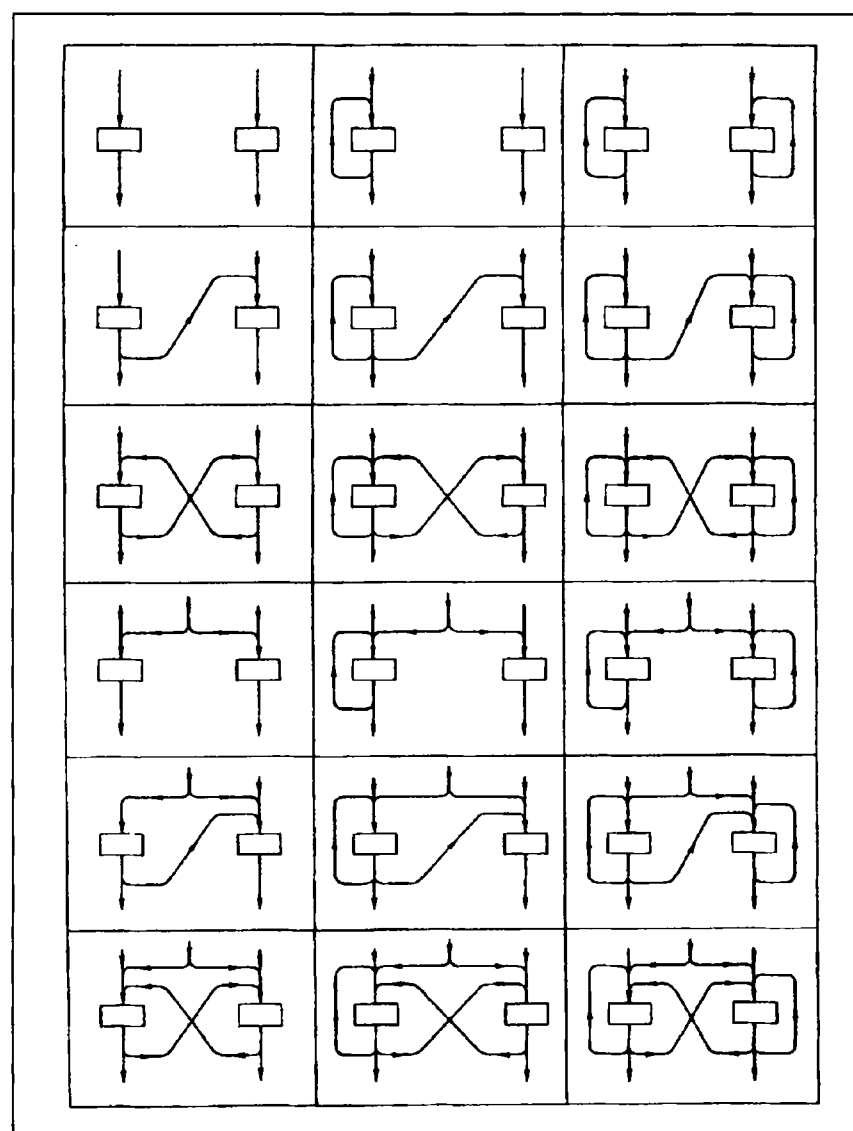
This problem is also related to the ways we construct our **reference frames** and thus suppose defined views about the way we perceive and how our **brain** constructs **explanations** and **models**.

BRYANT himself discusses these problems in various sections of his book (1991)

He even says that "all philosophies are **utilitarian**, either overtly or covertly" (p. 176) while in different ways and according to different **aims**.

As a result, the "C.L. model" seems quite strong in physical sciences. This situation could possibly be more or less amended in other sciences by adding systemic **models** and **rules**, as for example, "A system is more (and less) that the sum of its **parts**"

Figure: see entry **COUPLINGS between two elements**



All possible kinds of couplings in the vector form between two elements.
From G. KLIR: 1969, p. 155

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

0746

CREATION (Co-)^{1) - 2)}

The shaping of new **elements** or **structures** as a result of **interaction** between opposite forces.

According to D. SEIDEN and H. SABELLI (1992, p.720-27) any creation is co-creation, resulting from "unity, opposition and **triadic** space-like **structure**" (p.720). The basic root of co-creation is arithmetical, as "the science of **form** was born of art with the discovery of simple relations between string instruments and their sound (PYTHAGORAS), the divine proportion (FIBONACCI), the Golden rectangle (EUCLID) and other **forms** later found also in natural **processes**... These **forms** are the logic of nature, the logos (HERACLITUS) ... Small integers, non-dimensional numbers, and some geometrical **forms** are "logoi", i.e. universal **forms** embodied in **matter**... In our century, THOM developed the **theory of catastrophes** as mathematical **models** for the simpler **forms** of logoi" (Ibid).

Let us also refer to C. LAVILLE's study of **helixes** and **whorls** fed by interacting **fields** of **energy** shaping **forms** and **structures**.(1950).
→ **Toroid**

0747

CREATIVE DESTRUCTION¹⁾²⁾⁵⁾

A **process** of destruction of existing **structures** that opens the possibility for fundamental **change**.

This expression comes from economics and was introduced by the Austrian economist Joseph SCHUMPETER (1883-1950). According to Schumpeter, periodic **waves** of scientific discoveries and subsequent technical innovations trigger deep (and frequently traumatic) changes in economies and societies. Older trades and structures are destroyed and progressively replaced by new and very different ones. An example has been the destruction of older modes of transportation after the invention of the internal combustion engine (allowing the massive use of fossil **energy** of oil) and the deep **transformation** of economy, urban life and generally societies that resulted.

Moreover creative destruction appears to be a still more general **process**. Edgar Morin observes for example that all great religions of the world were predicated by one singular and exceptional individual (Moises, Jesus, Siddhartha, Mahoma, Luther). All of them triggered radical social and religious destruction and restructuring (1999, p. 79)

In fact creative destruction is a universal systemic evolutive process (from cosmology to biology, to business and to **culture**) whose significance seems to remain yet insufficiently explored, understood and managed (if possible!)

0748

CREATIVITY^{1) - 2) - 3)}

The ability to organize or re-organize **elements** into new complex **forms** and/or **processes**.

M. MARUYAMA offers the following systemic-cybernetic views about creativity: "It is a fallacy to equate creativity with capriciousness. A symphony is the opposite of **random noise**. Creativity involves the development of **patterns**, **differentiation** and **structure**. This is possible by means of **differentiation-amplifying mutual causal processes**..." (1979, p.210).

These **processes** are characterized by a well defined initial **situation**, the existence of different types of **elements** and of development **rules**. These conditions seem indeed to be the real bases of human, artistic (f. ex. musical, pictorial or poetic), scientific and technical creativity.

Such creativity is possible only in a minimally **constrained** and **structured conceptual space**. It can operate through the mechanism of **association** of two **conceptual matrixes**: A. KOESTLER's "**bisociation**". This author explains: "The basic **bisociative pattern** of the creative **synthesis** (is) the sudden interlocking of two previously unrelated skills, or **matrices** of thought" (1975, p.121).

H. ODUM offers another interesting angle: "Creative thinking requires an effectively motivated **random-thought generator** plus a well-developed **truth-reward response**" (1971, p.155).

Such a **concept** can be generalized in the following way: Creative **evolution** requires an effective **random-variety generator** plus a well-developed **fitness-reward response** device. This could even make the way easier for intelligent artifacts **evolution**.

Creativity involves, moreover, in D. BOHM and F.D. PEAT words: "... an extremely perceptive state of intense passion and high **energy** that dissolves the excessively rigidly held assumptions in the tacit infrastructure of commonly accepted **knowledge**" (1987, p.38).

The same authors observe that creativity can easily become blocked: "Basically the setting of **goals** and **patterns** of **behavior** which are imposed mechanically or externally, and without understanding, produces a rigid **structure** in **consciousness** that blocks the free play of thought and the free movement of awareness and attention that are necessary for creativity to act" (p.231).

Creativity is frequently stifled in this way by the imposition of excessive **constraints** in the very **process** of education. (The only necessary **constraints** in any system are those necessary for its **entification** - i.e. the definition of its **organizational closure**). Conceptual **order parameters** are necessary as **frames** for creativity, but excessively **constraining** ones kill it.

The same **situation** is also encountered in **human organizations** and in cultures, where **sclerosis** sets in when the **rules** become too numerous, too formal and finally downright oppressive.

As creativity supposes at least a reorganization of **conceptual space**, and sometimes the very creation of a new one, it is frequently not understood and rejected, at least for some time. This situation affected and still affects the creative work of the founders of systemics.

Many other stimulating insights in this subject, have been offered by M. BODEN (1990).

0749

CREDIT ASSIGNMENT¹⁾⁵⁾

In **rules based** adaptive **systems**, as for instance **pattern recognition machines**, but also, in a way more difficult to put in evidence, in biological and probably social systems, there is a constant need to evaluate the relative success of the **rules**. J. HOLLAND calls this **process** "credit assignment" and discusses it as follows: "Credit assignment is not particularly difficult where the **situation** provides immediate reward or precise **information** about correct **actions**. Then the rules directly involved are simply strengthened. Credit assignment becomes difficult when credit must be assigned to early acting rules that "set the stage", making possible later useful actions. Stage setting moves are the key to success in complex situations, such as in playing chess or investing **resources**. The problem is to credit an early action, which may look poor (such as the sacrifice of a piece in chess) but which set the stage for later positive actions (such as the capture of a major piece in chess). When many rules are active simultaneously, the problem is exacerbated. It may be that only a few of the early acting rules contribute to a favorable outcome, while others, active at the same time, are ineffective, or even obstructive. Somehow, the credit assignment **algorithm** must sort this out, modifying rule strengths appropriately.

"Credit assignment in classifier systems is based on **competition**.... That is, when a rule wins the competition, it actually "pays" its bid to the rule(s) that sent the **message(s)** satisfying its conditions. The rule acts as a kind of go-between or broker in a **chain** that leads from the stage-setting situation to the favorable outcome" (1992, p.176-7).

→ **Paralled distributed processing**

0750

CREEPING PROBLEMS¹⁾⁴⁾

Problems that are "the result of **long-term**, low-grade, and slow-onset **cumulative processes**". (M.H. GLANTZ, p.12).

GLANTZ adds, significantly, with more specific reference to **environmental** problems: "Creeping ... problems cut across academic disciplines, political **ideologies**, continents and **cultures**"

And "Incremental **changes** in environmental conditions accumulate over time with the eventual result that, after some **threshold of change** has been crossed, things "suddenly" appear as major degradation"...

"Creeping... problems thus change the **environment** in a negative **cumulative** and, at least for some **period of time**, invisible way. Both governments and individuals tend to continue to view their "usual activities" as acceptable".

A further trap is that: "Scientific **uncertainty** can also foster inaction" (Ibid). It can even be used by pressure interest **groups** in order to block needed **adaptations**.

→ **Change (Rates of); Effect (Delayed); Risk makers**

0751

CRISIS^{1) - 2)}

"Any sharp **transition**, any **changes** perceived by people as a **disturbance of continuity**" (A. BOGDANOV, (1921), 1980, p.229).

BOGDANOV distinguishes "C Crises", i.e., conjunctive or joining" and "D Crises, i.e., disjunctive, or separating".

He adds: "In essence, any **conjunction** begins with crisis C, the break-up of **boundaries**, and any **disintegration** of a complex originates from crisis D" (1980, p.235).

BOGDANOV admits however that in reality both types of crises are generally present under the form of "... a chain of elementary crises of both types" (Ibid).

In most cases, a destructive **phase** precedes a constructive **phase**: it is necessary that the older **structures** and **networks** break up in order to allow for some type of restructuring.

As observed by J. CALHOUN man is a crisis-provoker, probably the greatest ever.

0752

CRISIS SYMPTOMS IN HUMAN SYSTEMS⁴⁾

W.H. HARMAN characterized as follows the main symptoms of crisis in contemporary **human systems**:

" - **Interconnectedness**, so that laissez-faire approaches are less workable.

"- Reduction of geographical and entrepreneurial frontier opportunities.

"- Approaching **limits** of natural **recycling** capabilities.

" - Sharpened **dichotomy** between "employed" and "unemployed" (e.g. virtual elimination of the small farmer, partially or sporadically employed)

" - **Transition** from a basic condition of labor scarcity to one of job scarcity

" - Approaching **limits** of some **resources** (e.g. natural gas, domestic petroleum - i.e. from U.S. wells, fresh water)

" - "Faustian powers" of technology and industrialization that have reached the point where they can have a major impact on the physical, technological, sociopolitical and psychological **environment**

" - Expanded political power of labor which, forcing industrial wages to follow increasing productivity, constitutes an inflationary factor

" - More adequate supplying of deficiency needs (improved diet, material advance) plus more education, resulting in higher expectations and keener **perception** of the gap between actualities and potentialities" (1972, p.88).

This impressive 1972 list is still more valid in 1996. Some more items could be added:

- The still largely uncontrolled demographic **explosion** which is imposing a growing **strain** on all **resources**, renewable or not.

- Colossal squandering of **resources** in military spending and the resulting destructive **conflicts**.

- The general trend toward deficit spending at every **level** of public administration, with a global inflationary **effect**.

- The growing volatility of the world monetary and financial system, resulting from the newly worldwide **interconnection** of markets.

- The growing impact of clandestine and illegal business (drugs, bribes, etc.) which introduces an uncontrolled **instability** factor in economy and politics.

0753

CRITERION^{2) - 3)}

A **rule** or **standard** used to take **decisions**, emit opinions or define **categories**.

Any criterion is, of course, relative to the aims or conditions of its application. For example, we may favor a highly productive maize for economical reasons, but it may be at the same time highly susceptible to pests, or not well adapted to some natural conditions, as for example drought.

Criteria relative to systems **classifications**, or recognition of **structures** and **processes**, are of utmost importance for systems research and its **epistemological** foundations. They should always be enounced as clearly as possible.

A good example is the use of some kind of **rules** to define the **boundaries** of a system, in a more or less precise way.

0754

CRITICAL DIMENSION

→ **Size (Critical)**

0755

CRITICAL EFFECT¹⁾²⁾

An effect in a **process** which significantly changes the course or even the nature of the process.

In some cases the critical effect can either put an end to the process and eventually damage or destroy the system that depends on it.

Any critical effect corresponds to an **over-shooting**, i.e. the crossing of the **threshold** at which the process or systems loses its **dynamic stability** and turns totally **irreversible**. An example is the rupture of an aneurism, the effect resulting from a peak of blood pressure (the immediate **cause** within a protracted arterial degradation process)

The sudden effect is so dramatic that it end the very process that produced it, and initiates the total **destruction** of the concerned **living system**.

It is the case of the "camel's broken back" in the popular saying: the camel is doomed.

Epoch making historical **events** are thus considered because they usher new and very different social and political processes, i.e. while being results of anterior sequences, they mark a significant **discontinuity**.

→ **Chaos; Destructuration; Disasters; Disintegration; Disturbance; Emergence; Node (Critical); Nucleation mechanism**

0756

CRITICAL EVENT²⁾

An event "which occurs at a point of **instability**" (I. PRIGOGINE and P.M. ALLEN, 1978, p.48).

Such an event would be of little consequence in a **homeostatic system** adapting within its normal **limits of stability**. However, in **far from equilibrium** ones, even a very slight "push" can tip the system out of its **stability range** and bring on considerable consequences without any relation with its believed lack of importance. Turning points in **history** are frequently critical events. An example is the "Boston tea party", which ignited the American Revolution.

0757

CRITICAL FLUCTUATION²⁾

A **fluctuation** occurring very close to the **stability limit** of a system.

Critical fluctuations are closely related to the triggering of **dissipative structuration** in systems **far from equilibrium**.

0758

CRITICAL PATH^{2) - 5)}

A tree-like **network model** extended in the **time dimension**, used for the chronological ordering of a series of tasks related to a complex undertaking.

I.G. BLOOR describes the basics of the technique as follows: "Float calculations indicate where there is spare **time** in the **network** and "critical path" highlights which particular sequence of activities within the project determines the minimum completion **time**" (1987, p.32).

These **models** are very useful to avoid contradictions or unduly slowdowns. They should however be frequently monitored and eventually adapted to new circumstances that may appear.

0759

CRITICAL POINT²⁾

A point where the **behavior** of the system changes significantly.

R. THOM uses it as a synonym for **singularity** (1993, p.147). Another very close meaning is that of "**threshold**".

K.DE GREENE makes this very significant comment: "Near critical points, the system acts as a **whole**"

0760

CRITICAL SLOPE²⁾

The particular value of the slope of a pile of loose **homogeneous** material, at which **instability** sets in.

This critical value is reached by progressive **addition** of material to the pile. If further grains are added, the surface grains will slide off and leave the slope unchanged.

The angle made by the slope and the flat base of the mound is called "angle of repose".

Critical slopes are proper of mounds of materials devoid of viscosity. Any degree of viscosity allows for the **accumulation** of **stress** and creates a potential for **runaway events**.

0761

CRITICAL STAGE²⁾

The moment at which some system's **function** either becomes controlled by a countervailing **process**, or undergoes a **runaway process** through unchecked **growth** towards **collapse**.

Critical stages, characteristically, are not perceived by "**linear**" thinkers. As a result, **collapse** is upon them before they realize that it is going to happen and they are totally unable to correct course before it is too late.

Growth functions can generally be modeled by **logistic** curves, where the critical stage appears as an inflexion point. However, such a **model** implies the understanding of the existence of a potential braking **process**, which may be natural or purposely introduced.

0762

CRITICAL STATE²⁾

A **metastable state** in a **composite system** such as a small **perturbation** may (or not) induce a giant **fluctuation** or **runaway event**.

After any **perturbation** (strong or weak), a **composite system** tends to return its critical state, which is characterized by **fluctuations** commanded by a **flicker noise** such as small **fluctuations** are quite frequent and readily **predictable**, while giant ones are rare and quite **unpredictable**.

Good examples are the small **fluctuations** in stock markets as opposed to the great crashes, or the small quakes as opposed to great destructive seisms.

0763

CRITICAL STATE (Sub , super-)²⁾

In **composite systems**, the subcritical states do not allow for a significative **propagation** of some local **perturbation**, obviously because the **clusters** generally are not linked.

In the critical state, the **linkages** lead to a considerable **propagation** of the initial **perturbation**.

In the supercritical states, the **perturbation** propagates itself to most of the system (sudden global chain reaction or **runaway event**).

0764

CRITICAL VALUE^{1) - 2)}

A **parameter** value bringing about a sudden **change** in a **process** or in the **state** of a system.

Critical values are more or less easy to determine and to measure in physical and biological systems. In **ecosystems**, it is already more difficult to find out what exactly should be measured.

Critical values also obviously exist in economic and **social systems**: Their crossing leads for example to **runaway** inflation, devaluations of currencies, revolutions, wars and empires **collapses**. However, the sensible **parameters** themselves must first be discovered, which is no mean task.

0765

CRITICALITY^{1) - 2)}

"Characteristic of a system where the individual **degrees of freedom** keep each other in a more or less stable balance, which cannot be described as a "**perturbation**" of some decoupled **state**, nor in terms of a few collective degrees of freedom" (P. BAK. C. TANG & K. WIESENFIELD, 1988, p.364).

The authors give as an example: "...ecological systems (which) are organized such that the different species "support" each other in a way which cannot be understood by studying the individual constituents in isolation. The same in-

terdependence of species also makes the **ecosystem** very susceptible to small **changes** or "**noise**". However, the system cannot be too sensitive since then it could not have evolved into its present **state** in the first place. Owing to this **balance** we may say that such a system is "critical"... this criticality can be put on a firm quantitative basis" (Ibid).

Further on, the authors state that this class of **composite systems** "has a specific temporal fingerprint, namely "**flicker noise**"... characterized by **correlations** extended over a wide range of **time scales**, a clear indication of some cooperative effect".

Flicker noise is in fact not **noise** but reflects the intrinsic **dynamics** of **self-organized** critical systems" (Ibid)

"Another signature of criticality is spatial **self-similarity**" (Ibid).

Thus criticality is characteristic of not strongly **integrated systems** (as for example ecological or climatic ones) or almost **homogeneous** systems (i.e. with a very limited number of classes of **components**).

It seems related to countervailing statistical **regulations** which maintain the **composite system** within a **channel** of dynamic but turbulent **stability**, which evokes also the concept of **chaotic attractor**.

Note: In a more recent paper, P. BAK (with K. CHEN) use the label "**composite system**" in lieu of "**dynamic system**" which seems more adequate. In this dictionary we also use the expression: "Almost **homogeneous** system".

→ **Flicker noise**

0766

CRITICALITY AND PERCOLATION^{1) - 2)}

While criticality in a **composite system** corresponds to its tendency to turn back to a defined **critical state** which acts as an **attractor** (BAK et al., 1988, p.365), conversely percolation corresponds to its tendency to **runaway behavior** when a **percolation threshold** is reached.

This is made clear by P. BAK, C. TANG and K. WIESENFIELD who write: "The system will become **stable** precisely at the point when the **network** of minimally stable **clusters** has been broken down to the **level** where the **noise signal** cannot be communicated through infinite distances" (Ibid, p. 367).

Most of the **percolation processes** tend to spend themselves quickly because they destroy their own conditions of permanence. For example, a **population** crash is the customary result of a **population** explosion. The **composite system** whose this **population** constitutes a class of **elements** tends to go back to its **critical state**, which is thus "self-organized". It is in this case that "the **network**... has been broken down to the **level** where the **noise** cannot be communicated through infinite distances" (Ibid).

Obviously the **percolation threshold** of the **composite system** is closely related to its **critical state** "in which minor **events** can cause chain reactions of many sizes" (P. BAK & K. CHEN, 1991, p.32). A **percolation event** is probably a **runaway fluctuation** initiated in favorable conditions by a small one.

0767

CRITICALITY (Self-organized)^{1) - 2)}

Condition of a "dynamical system with extended spatial **degrees of freedom** in two or three dimensions" which "naturally evolves into a self-organized **critical state**" (P. BAK, C. TANG & K. WIESENFELD, 1988, p.365).

The authors state: "By self organized we mean that the system naturally evolves to the **state** without detailed specification of the **initial conditions** (i.e. the **critical state** is an **attractor** of the **dynamics**). Moreover, the **critical state** is robust with respect to variations of **parameters**, and the presence of quenched **randomness**" (Ibid).

However more recently P. BAK and K. CHEN state; "...**composite systems** may never reach **equilibrium** but instead evolve from one **meta-stable state** to the next" (1991, p. 26). They add: "During the past four years, experiments and **models** have demonstrated that many **composite systems** at the heart of geology, economy, biology, and meteorology show signs of self-organized criticality. These insights have improved our understanding of the **behavior** of the earth's crust, stock markets, **ecosystems** and many other **composite systems**" (Ibid).

Self-organized criticality has two "signatures" or "fingerprints" in P. BAK's and al. terms:

- a spatial ones which appears as a **fractal structure** specified by a **power-law**
- a temporal one which corresponds in each case to a specific **flicker-noise**

These abstract explanations become clearer when connected with ASHBY's concepts of **ultrastability**, non determined **transformation** and **transition's probabilities matrix**, all related to **composite systems** (See his "Introduction to Cybernetics").

St. KAUFFMAN uses the criticality model in the co-evolution **dynamics of populations** (1993, p.256).

P. BAK comments: "... regularity of **catastrophic events**, **fractals**, **1/f noise**, and **Zipf's law** - are so similar, in that they can all be expressed as straight lines on a double logarithmic plot, that they make us wonder if they are all manifestations of a single principle....- Maybe self-organized criticality is that single underlying principle.

"Self-organized **critical systems** evolve to the complex **critical state** without interference from any outside **agent**.

The **process of self-organization** takes place over a very long transient **period**. Complex **behavior**, whether in geophysics of biology, is always created by a long **process of evolution**. It cannot be understood by studying the system within a **time frame** that is short compared with this evolutionary **process**. The phrase "you cannot understand the present without understanding **history**" takes on a deeper and more precise **meaning** (1996, p.31).

BAK also observes that "self-organized criticality can actually be thought of as the theoretical underpinning for catastrophism, the opposite philosophy to gradualism" (Ibid, p.131).

Both views are useful in their own way, for instance in **evolution theory**. BAK writes: "If the theory of self-organized criticality is applicable, then the **dynamics of avalanches** represent the link between DARWIN's view of continuous evolution and the punctuations representing sudden quantitative and qualitative **changes**. Sandpiles are driven by small changes but they nevertheless exhibit large catastrophic **events**" (Ibid).

0768

CROSS FALSIFICATION

→ **Falsification (Cross)**

0769

CROSS LEVEL RESEARCH (in living systems)^{1) - 3)}

J. MILLER, who has actively promoted cross-level research as a general **systems methodology**, proposes three degrees of generality for it:

"The first predicts that a formal identity and/or disidentity is present across individual systems of the same species or type. A research that tests the hypothesis that individual rats differ among themselves in the **rates** at which they characteristically learn to run mazes is of that sort.

"Cross-type or cross species generalization is the second degree of generality of hypothesis. Such **generalizations** are more powerful than the first sort. Also they involve more **variance**. Research in comparative anatomy, comparative physiology, comparative psychology, and comparative sociology is of that sort.

"The relative **size** of skulls of rats, cats, dogs, dolphins, apes, and human beings, for instance, can be compared with the average measures of intelligence of each species to confirm the hypothesis that animals with larger skulls - and larger **brains**- have greater cognitive capacity. Of course there is also variance among individual members of a single species.

"The third type of scientific **generalization** is from one **level** to another. These cross-level **generalizations** will, ordinarily, have greater **variance** than the other sorts since they in-

clude **variance** among types and among individuals. They can, however, be made. They can enable insights and discoveries made at one **level** to give rise to general principles which apply to multiple **levels of living systems** and, in some cases, to nonliving systems and technologies as well. As **understanding** of systems in general increases, fragments of **knowledge** may coalesce into **patterns** and science as a whole may become more coherent. Indeed, evaluating the validity of cross-level hypotheses may become a very significant innovation in the study of **living systems**.

"Scientists undertake cross-level research less frequently than cross-individual or cross-type. There are a number of reasons for this. Scientists are trained to be specialists in one or another of the many disciplines and subdisciplines into which the subject-matter of science is traditionally divided. They limit the scope of their expertise on the grounds that one person cannot be informed in depth and expert on a broader range of **phenomena**. The usual **patterns** of rewards to scientists, including academic promotion and tenure, recognition in national scientific societies, grant awards, prizes, and so forth reinforce **specialism**. What is more, the traditional cautiousness of scientists makes them skeptical of any **generalization** from, say, a **cell**, to a system as different as an **organism** or a society. Scientists working at one **level of living systems** are rarely current with the literature at other **levels**. This is demonstrated by the paucity of references to researchers at other **levels** in the texts or bibliographies of scientific papers. As a result, when a scientist discovers a principle at one **level**, he typically does not think it likely enough to be relevant to another **level** to take the trouble to find whether similar principles have been reported in the literature at other **levels**.

"General **living systems theory** in no way denies the importance of specialists' **knowledge** or the advancement of **understanding of phenomena** in limited scientific areas. Specialized research will properly continue to be the chief means by which science advances. At the same time, however, there should be studies of generalities or similarities, as well as differences, among different classes of **phenomena**" (1986, p.74-76).

0770

CROSSBAR²⁾

The **connection mode** in which every **element** can be connected with every other one.

Telephone nets are constructed in this way. See "**connection modes**".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0771

CROSS-DISCIPLINARY ^{1) - 3)}

A basic characteristic of systemics, which allows the uses of **analogies**, **homomorphisms** and **isomorphisms** between different disciplines as a **methodology**.

According to G. KLIR, this characteristic implies at least three important consequences: "First, systems science **knowledge** and **methodology** are directly applicable in virtually all disciplines of classical science. Second, systems science has the **flexibility** to study systemhood properties of systems and the associated problems that include aspects derived from any number of different disciplines and specializations of classical science. Such cross-disciplinary systems and problems can thus be studied as **wholes** rather than collections of the disciplinary **subsystems** and subproblems. Third, the cross-disciplinary orientation of systems science has a unifying influence on classical science, increasingly fractured into countless numbers of narrow specializations, by offering unifying principles that transcend its self-imposed **boundaries**. Classical science and systems science may thus be viewed as complementary dimensions of modern science" (1993, p.29).

0772

CROSS-IMPACT ²⁾

The reciprocal influence of one **event** or **process** on other ones.

While direct **interactions** are evident and generally taken into account, many other ones which are not so obvious, are frequently ignored or neglected. A **graph** or **matrix** of the various intervening **elements** or **processes** helps find out which **interactions** are effective and significant, within the totality of the possible ones.

0773

CROWD PHYSICS ²⁾⁵⁾

The **rules** of spontaneous self-ordering of a great number of individual **elements** in movement within a confined **space**.

This curious systemic **phenomenon** can be observed in widely different settings, as for example in heavy traffic in truncl roads, or in crowded lobbies or staircases, or in fish **schools** (spatially confined to secure better protection against predators).

It seems related to a general reciprocal collision avoidance **behavior** - combined with specific advantages of groupal **dynamics** for a better use of **energy**.

This type of behavior appears at very distinct **levels** of global **organization**.

In **BENARD's instability** and **structuration** by **energy dissipation**, it is a result of basic **thermodynamic processes**. The **BELOUSOV-ZHABOTINSKY** catalytic **reaction** is an example in chemistry, also based on **thermodynamics**.

GRASSÉ's **stigmergy** shown in termites building their mounds seems to be another example, wherein reciprocal sensorial **stimulation** starts to be a predominant factor. The shaping of locusts **swarms** from individual insects under some specific **environmental** conditions leading to crowding in a reduced space, is also an example. Somehow, as stated by von FOERSTER **order feeds on noise**" (1960, p. 31-50)

0774

CROWDING EFFECTS ^{1) - 4)}

It has been quite frequently observed that crowding in animal **populations** tends to modify the **behavior** of the individual participants and to create collective **behaviors**. In some cases these are merely gregarious, but in others they seem to lead to incipient **sociality**.

This **phenomenon** has been documented in the well known amoeba **dictyostelium discoideum**, in sponges, in schools of marine invertebrates and of fishes, in various species of locusts, in starlings, in naked mole-rats, etc...

Crowding seems to modify the reciprocal **perception** in the individuals in the crowd, through physical, biochemical, optical and other **effects** that appear to become effective only with closer **proximity**.

Crowding effects in human masses, at the physiological as well as the psychological **level** are also well established. It may even be observed in the **behavior** of drivers-vehicles systems on an overcrowded road.

Under different forms, this **phenomenon** seems to be present at the microphysical and the chemical **levels**. Its basic mechanism could be usefully researched as a genuine systemic-cybernetic **model**: a **cross-feedback process** related to high **density**.

Precursors in the study of crowding effects in human masses have been the French sociologist G.LE BON (1895, U.S. translation 1960) and the italian S. SIGHELE (1892). Crowding effects in general have been extensively researched by J. CALHOUN (1962), J.J. CHRISTIAN (1959), J. FREEDMAN (1975) and others.

The french sociologist R. BOUDON describes the effects of crowding as "perverse", which means that individual **functions** are somehow impaired when they become massively competitive. This kind of **effects** leads either to global blocking or to higher **level sociogenesis**.

0775

CRUNCH ^{1) - 2) - 4)}

A critical decrease of possible alternatives for **action** due to a reduction of available **space**, usable **resources** and or a shortening of **time limits**.

Crunches corresponds to a limitation of the systems **variety** or **diversity** both in **space** and **time**. They generally appear quite suddenly, in relation to long or **very long term** exceptional **accumulative effects**.

R. THEOBALD emphasized the importance of "decision crunches" due to accelerating **changes** in the technical and social **environment** of **human systems**. (ISSS Conf. Asilomar, 1994)

J. WEINS proposed the **concept** of environmental crunches, due to **disturbances** in **eco-systems environments**, which reduce **resources** and provoke a more intense **competition** within the system (1977, p.590-7).

0776

CUE ¹⁾²⁾

A characteristic or **signal** in a **stimulus** which implies a specific **meaning** in the **stimulus**.

Cues are related to **implicit knowledge**, as it results from anterior **learning** allowing the recall of a similar **meaning** in more or less similar circumstances.

0777

CUES (SOCIAL) ⁴⁾

Signals that the individuals may perceive as a result of the **collective behavior** of their **group**.

Social cues are obvious in practically all forms of societies, animal or human.

They are very diverse in nature: concentrated **pheromones**, collective **behavioral change**, **rituals**, ideological calls, etc.

They are kinds of **feedbacks** between the individuals and their **group**. Public opinion, for example, as in a famous engraving by A. BÖCKLIN, is a **self-reproducing fractal** monster. Every individual is imprinted in the same form by his collectivity and contributes to the permanent **reproduction** of the collective behavior, in a kind of systemic scaling **self-similarity**.

Social cues may sometimes evolve, but this **process** is generally quite slow and may be hazardous. Radical **shifts** of social clues types are very exceptional, as expressed through the famous sicilian "Gattopardo" behavior described by LAMPEDUSA: "Introducing some **change** in order to maintain things as they are"

Of course, when the social clues lose their clear **meaning**, the society is in great danger to lose its bearings.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0778

CULTURAL FEASIBILITY→ **Feasibility (Cultural)**

0779

CULTURE⁴⁾

The **set of values** and **norms** proper to a social system.

These **values** and **norms** act as collective **order parameters**. They include beliefs (religious, aesthetic, ethical, philosophical), basic **concepts**, law systems, political ideologies, technical practice, dominant economic attitudes, etc...

The basic **values** and the resulting adaptive **norms** correspond to the **autopoietic** character of a given **sociosystem**, which must however adapt to internal and **environmental change**. It strongly polarizes nearly all the individuals in the system, through reciprocal **behavioral constraints** and, in turn, generates the **behavior** and attitudes needed to maintain its global **coherence**, **efficiency** and in some extreme cases secures its very **survival**.

When the **values** and **norms** are starting to crumble, the **sociosystem** generally finds itself in the middle of a terminal **crisis** and/or facing a critical transition toward other **forms** and ways.

Culture seems to have ethological roots in social mammals and birds, and even possibly biochemical ones as in insect societies, and amoeba.

0780

CULTURES AS SYSTEMS⁴⁾

The common acceptance by a numerous group of people of a set of **values** and **norms** tend to create a dynamically stable entity which maintains itself with recognizable characteristics during quite a long **span** of **historical time**.

It becomes conceptually acceptable to speak of "cultural systems". Their main characteristics are:

- each one offers basic features, **values**, **beliefs** and **norms**, a **language**, specific aesthetics, a folklore
- two or more different cultures may find it quite difficult to communicate
- a cultural system generally exists in more or less well defined and stable spatial **boundaries**
- the values and norms of the culture are transmitted from one generation to the following by a kind of psychological imprinting, which guarantee their survival ("**historical consciousness**")
- cultures evolve and finally tend to decay and disappear; but may leave traces and thus contribute to the inheritance of new cultures in the making

- individuals pertaining to a culture adapt themselves very uneasily in another one and are also frequently discriminated (nationalism, religious fanaticism, racism, etc) (R. ARON, 1961)

Of course, a member of a cultural system views his/her systems in function of the received imprinting, from which it is very difficult to escape

→ **Aura; History (Sistemic)**

0781

CULTUROCENTRISM¹⁾⁴⁾

The mental attitude and worldview that tends to interpret **facts** or **issues** from the sole- and generally narrow- viewpoint of the **values** and **norms** of one's own **culture**.

Culturocentrism restricts very seriously (and at times, blocks) our **understanding** of "aliens" (the "barbaroi" of the old Greeks, a word whose present **meaning** reflects our obvious own culturocentrism)

Such attitude derives easily into deep misunderstandings, mistrust, hostility, intolerance, fanaticism and even criminal **behavior**. As we receive kind of an **imprinting** from our own culture, it is very difficult, however, to escape from culturocentrism.

This kind of bias seems also to exist in our understanding of historical cultures: a contemporary man or woman has probably a quite fanciful view of Middle Age life for instance.

One of the most useful goals of science in general and systemics in particular could be the construction of a world-widely accepted consensual understanding of some general **concepts** and models, to which cybernetics and systemics could make a valuable contribution.

→ **Anthropocentrism**

0782

CURVE (Involving)²⁾

A curve representing a **long-** or very **long-term process**, which includes more or less **self-similar** curves at **medium** and/or **short term**.

This notion was introduced by F. ZWICKY (1971) for use in **forecasting**.

It was however already implicit in K. **WEIERSTRASS's** renormalization **function**. It has also been used by F. MEYER (1954) to emphasize the **evolutional acceleration process**.

The subject could be related to **ergodicity**, **deterministic chaos** and, possibly to a **fractal concept of time**.

0783

CUSP²⁾

"Development of a **bifurcation** in which one of the **two states** is reached from the other by the **action** of an external force" (R. FIVAZ, 1991, p.31).

This is one of the elemental **catastrophes** described by R. THOM.

0784

CYBERNATION¹⁾

"The ongoing **process** of **regulation** and **control**".

Cybernation implies maintaining the system within some defined **limits** by the programmed use of **positive** and **negative feedbacks**, according to incoming **inputs**.

0785

CYBERNETICS^{1) - 3)}

1) "The field of **control** and **communication** in the animal and the **machine**" (N. WIENER, 1948, p.19).

N. WIENER's original view is in fact quite mechanistic and corresponds to what became known as **1st Cybernetics** or **Cybernetics of the 1st order** (The latter, including **2nd Cybernetics**).

2) "The study of systems that are open to **energy** but closed to **information** and **control** - systems that are **information tight**" (W.R. ASHBY, 1956, p.5).

ASHBY's view is quite close to WIENER's: "Cybernetics deals with all forms of **behavior** insofar as they are regular, determinate or reproducible... What cybernetics offers is the framework in which all individual **machines** may be ordered, related and understood" (p.2).

WIENER's and in a lesser measure ASHBY's viewpoint, have aroused considerable resistance in human sciences researchers.

ASHBY himself however also wrote: "Cybernetics treats, not things, but ways of behaving. It does not ask, "What is this thing?" but "what does it do?"...It is thus essentially **functional** and **behavioristic**... The materiality is irrelevant, and so is the holding or not of the ordinary law of physics" (1956, p.1).

And, moreover: "The truth of cybernetics are not conditional on their being derived from some other branch of science. Cybernetics has its own foundations" (Ibid).

German cyberneticians, at least until 1970 preferred a quite formal view, as may be appreciated in the four following definitions by K. STEINBUCH, H. FRANK, F.von CUBE and G. KLAUS:

3) "Science of informational **structures** in technical and non-technical domains" (basically concerned with **data** treatment) (STEINBUCH, 1955, p.325).

4) "The theory and technique of systems which transform **messages**" (FRANK, 1969, p.30).

5) "(the) mathematical and constructive treatment of general **structural relations**, **functions** and systems" (von CUBE, 1967, p.11-16).

6) "The theory of interconnectedness of possible dynamic **self-regulated** systems with their **subsystems**" (KLAUS, 1965).

The Russian cybernetician V.M. GLUSHKOV proposed in 1966 a quite similar technical concept of cybernetics:

7) "(the general theory of the **transformation of information**, and ... the theory and principles of building various transformers of **information**" (1966).

GLUSHKOV included in his book theories of **algorithms**, of discrete **automata**, of **self-organizing systems** and of mathematical logic. V.G. DROZIN observes that "... its contents overlap somewhat with that of Computer Science as taught in our country" (i.e. U.S.) (1976, p.30).

8) "Discipline which studies **regulations** and **communication** in the living beings and the man-built **machines**" (J.de ROSNAY, 1975, p.93)

Quite significantly, de ROSNAY uses the word "**regulation**" in lieu of "**control**" used by WIENER. As a biologist he is more attuned to the non intentional aspect of **regulation**. This seems better if one remembers that many biologists, psychologists and sociologists reacted negatively to cybernetic "**controls**", that they considered a mechanistic **reductionism**, apt moreover to induce possible manipulations of human (and animal) **behavior**.

On the other hand, de ROSNAY adds: "A more philosophical definition, proposed by L. COUFIGNAL in 1958, views cybernetics as "the art to ensure efficacy in action". The word "cybernetics" has been reinvented by WIENER in 1948, from the greek word "kubernetes", which means pilot or steering wheel. One of the very first cybernetic mechanisms of velocity **regulation** in a steam machine, invented by James WATT and Matthew BOULTON in 1788, was called "governor"... Cybernetics has thus the same root as "government": the art of managing and lead highly **complex systems**. (Ibid).

From 1960 on, a less mechanistic view of cybernetics started to emerge, with St. BEER, G. PASK, H.von FOERSTER, M. MARUYAMA, H. MATURANA, and other researchers.

According to St. BEER: "... cybernetics studies the **flow of information** round a system, and the way in which this **information** is used by the system as a means of controlling itself: it does this for animate and inanimate systems indifferently. For cybernetics is an interdisciplinary science, owing as much to biology as to physics, as much to the study of the **brain** as to the study of computers, and owing also a great deal to the formal **languages** of science for providing tools with which the **behaviour** of all these systems can be objectively described" (1966, p.254).

One wonders if BEER would still have used the word "objectively", since it is now generally admitted that scientific **knowledge** may some-

times be "falsified" (POPPER), and results of a **consensual process** through **conversation** (PASK). Of course and notwithstanding, we still can safely *postulate* the existence of an objective reality and all this does not impair the usefulness of the cybernetics' **models**.

Further along BEER adds: "... cybernetics is precisely *about organization* – for this is the medium through which **control** is exercised. Therefore cybernetics may also be defined, as it has been by certain Russian writers as the science of effective **organization**" (Ibid., p.425).

In any case, BEER's view is not mechanistic: "Cybernetics begins where the possibility of **algorithmization** of the controlled system ends" (Quoted by V.G. DROZIN, 1976, p.28).

According to K. KRIPPENDORFF: "In cybernetics, theories tend to rest on four basic pillars: **Variety, circularity, process** and **observation**" (1986, p.20).

As stated by this author, **variety** is closely related to **information, communication** and **control**. **Circularity** is a necessary result of **feedback**, and leads to **autopoiesis**. **Process** is implied in **feedback, communication, regulation** and **control**, and **observation** is the basic condition for **decision making** and **control**.

Historical note: The word cybernetics was used for the first time by PLATO in the sense of "pilot's craft" or "the art of leading men". R. VALLEE states that, in 1834, the french physicist AMPERE used it in his "Essai sur la philosophie des sciences" to name the "study of the means of governing".

VALLEE adds: "In 1843, TRENTOWSKI did the same with the word *kibernetiki* in a book on **management** written in Polish", and still: "(W.S. McCULLOCH) liked to put cybernetics under the aegis of DESCARTES who proposed in 1664, an interpretation of cybernetical type, involving **feedback**, within the framework of his theory of nervous **transmission**. On the contrary WIENER considered LEIBNIZ (1646-1716) as the patron of cybernetics" (1993, p.84).

Table: see entry **Cybernetics (First and Second Order)**

Author	First order cybernetics	Second-order cybernetics
WIENER	mechanism	structural couplings
von FOERSTER	cybernetics of observed systems	cybernetics of observing systems
PASK	the purpose of a model	the purpose of a modeler
VARELA	controlled systems	autonomous systems
UMPLEBY	Theories of social systems	Interaction between observer and observed
UMPLEBY		Theories of the interactions between ideas and societies .

Other important precursors of cybernetics were the Russian BOGDANOV (1921), the Rumanian Stephan ODOBLEJA (1938), as well as W. CANNON (1932). The French biologist P. VENDRYES discovered independently the mechanisms of **homeostasis** and **autonomy** (1942).

In fact, the cybernetic **model** is implicit in numerous **concepts** and artefacts, since Antiquity.

0786

CYBERNETICS (First and Second Order)¹⁾

Stuart UMPLEBY explains as follows the differences between Cybernetics of the 1st and 2nd order.

"Cyberneticians have distinguished the recent work in cybernetics on **constructivist epistemologies** from the earlier work on **control** systems by using the term "second-order cybernetics". This term was first used by Heinz VON FOERSTER, who defined first-order cybernetics as the cybernetics of observed systems, whereas second-order cybernetics is the cybernetics of the observing systems (von FOERSTER, 1979). von FOERSTER intends the term "observing systems" to be interpreted in two ways: either systems that observe or the act of observing systems. Gordon PASK made a similar **distinction** when he defined first-order cybernetics as dealing with the **purpose** of a **model**, whereas second-order cybernetics deals with the **purpose** of the modeler. Francisco VARELA suggested that first-order cybernetics is concerned with **controlled** systems, whereas second-order cybernetics is concerned with **autonomous** systems" (1990, p.112).

S. BRIER enounces as follows the program of 2nd order cybernetics: "The basic concepts developed...are **autopoiesis**, closedness, **Eigenvalues** and the idea that the production of **information** is internal to the **autopoietic system**, and that **perception** and **communication** are based on **structural couplings**"(1995, p. 6)

Closedness should be understood as **organizational closure** obtained through **recursivity**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

S. UMPLEBY proposed "two additional conceptions of second-order cybernetics (1979). First-order cybernetics can be said to be concerned with **interactions** among the **variables** in a system, whereas second-order cybernetics is concerned with the **interaction** between the **observer** and the observed. The final definition goes beyond the one-brain problem of psychology or **artificial intelligence** and focuses instead on the **n-brain** problem of communities or societies" (p.112).

The following table gives a summary of UMPLEBY's views:

TABLE 1. Definitions of First- and Second- Order Cybernetics (p.113)

→ **Cybersemiotics**

see table page 146

0787

CYBERNETICS (First Order) or CYBERNETICS (1st)^{1) - 3)}

There is some ambiguity in these terms.

The first cybernetics is WIENER'S **control** cybernetics.

According to H.von FOERSTER, the 1st order cybernetics is the theory of **homeostatic systems**, wherein the concept of **regulation** tends to replace the one of **control**.

However, **self-regulation** already implies **organizational closure** and so, we shift to **cybernetics of 2nd order**.

WIENER himself defined Cybernetics as "**Control and Communication** in the animal and the **machine**" in the very title of his *Opus Magnum*.

The basic instrument of **control** is **feedback**, the **mechanism** used in **regulators**, which permit the monitoring of **deviations** and their subsequent correction.

This **mechanism** can be found in natural as well as in artificial systems. However, it has been discovered, at least explicitly, in natural systems, only after its discovery, use and explanation in artificial ones.

The (unconscious) discoverers of **feedback** were old-time craftsmen. The use and construction of **regulators** started to systematize from James WATT on and shifted from craftsmen to engineers.

Thus, the **concept** of **control** came to imply the idea of voluntary correction of some **deviation** and, during the last fifty years very numerous **control** devices of various types have been constructed.

The "**reliable automaton**" became the typical creation of cybernetics and its popular form, the "**robot**", imposed itself to the imagination of the man in the street. Meanwhile, psychologists, social scientists and ecologists began to mistrust this new science, whose apparent or at least potential aim was the perfect mechanistic **control** of everything, including man and

society. The Orwellian nightmare seemed suddenly possible and menacing, as well as some others, readily described by science-fiction authors.

Rigorous **planning** and Skinnerian conditioning seemed to indicate real and practical ways to this perfect **control**, dreamed of by would be perfect **controllers**.

As WIENER states: "The thought of every age is reflected in its technique" (1948, p.49 of the Hermann Edition). Obviously, **control** in its **algorithmical** sense reflects the more or less totalitarian mind and spirit (and possibly the scientific "ubris") of many mid-20th century leaders in most fields.

The study of **algorithmic control of artifacts** and **communication** devices by WIENER, SHANNON and WEAVER, TURING, von NEUMANN and others, around 1945-1960 has been the core of the first cybernetics.

The basic problem was: "How to **stabilize** systems and maintain them in as strictly possible defined **limits of behavior**".

In H.von FOERSTER words: "First order Cybernetics developed the **epistemology** for comprehending and simulating biological **processes** as, e.g. **homeostasis**, **habituation**, **adaptation**, and other first-order **regulatory processes**" (1974, p.16). This was of course quite better than the former: "How to lead a system to a final ideal and absolutely stable state". But it was still far from the **2nd. order cybernetics**, which tries to understand adaptive **autonomy** and, further, shifting **adaptability**.

W. Ross ASHBY and H.von FOERSTER started this **2nd. order cybernetics** on its way during the fifties.

As to the **runaway** and **deviation amplifying processes** resulting from non-compensated **positive feedbacks**, their study was seriously started in the sixties, especially by Magoroh MARUYAMA (1963, p.164-79), who called this, the **2nd. cybernetics** (not to be confused with **2nd. order cybernetics**).

As in the 1st. Cybernetics it is basically concerned with "the system to which is attributed qualities of objective **reality**, and to which the act of **observation** makes no difference (Of course scientists know that this is an over-simplification, but it is conveniently easy to handle)" (R. GLANVILLE, 1979, p.35).

As a result "... its shortcomings have been traditionally obscured" (Ibid).

→ "**Reality**" (**Riddle of**)

0788

CYBERNETICS (Second)¹⁾

The cybernetics of **deviation-amplifying processes**.

This development of cybernetics, centered on **positive feedbacks**, was introduced by M. MARUYAMA (1963, p.164-79, or in J. MILSUM (Ed.), 1968).

It considers the conditions that permit the **amplification** of small initial **deviations** until very considerable, and sometimes **runaway effects** are produced.

This is quite at variance with **control** cybernetics, whose aim is precisely to maintain **processes** and systems within their **stability channels**.

MARUYAMA also considers the cases where various amplifying **processes** interfere, causing progressive **structuration** (See: "**Causal process (Mutual)**")

MARUYAMA's **model** has been confirmed in a different way through I. PRIGOGINE's **dissipative structuration model**.

It is also a kind of **cellular automaton**.

0789

CYBERNETICS (Social)

→ **Social Cybernetics**

0790

CYBERNETICS (Technical)⁵⁾

Technical cybernetics is mainly concerned with the study and construction of **control** and **communication** systems.

In I.G. BLOOR's words: "As a technique it has become the **design template** for mechanical and electronic systems and latterly the **design of Management Information Systems**. Cybernetic theory requests that all **inputs** to, and **outputs** from a system must be defined or designed together with suitable "**triggers**" or **sensor mechanisms** to detect any **change in activity or response**" (1987, p.8).

The main core of cybernetic technique is the **control** device, which must monitor and measure such **changes**, compare them with specified **standards**, calculate a corrective **action** if needed and trigger it, using specific means to do so.

Communication cybernetics is concerned with the technical conditions of **coding**, **transmitting** and **decoding messages**. This includes the construction of suitable **channels**, devices to compensate **noise** and the eventual production of suitable **redundancy**.

Cybernetic technique is also implied in computer hardware and software, in **artificial intelligence** and **expert systems**, in **robotics** and **bionics**, in the new fields of **artificial life**, virtual reality and **information** "highways".

0791

CYBERNETICS (The scope of)^{1) - 3)}

G. PASK formulated the following opinions about the scope of cybernetics:

"... tough I can see the difference between cybernetics, **General Systems Theory** and Cognitive **Information Science**, I fail, completely, to see its practical significance unless a very specific piece of work is in mind; and, as a result of that, fail also to get in the least irritated if these terms are misapplied..."

"I believe that Cybernetics (and the allied sciences) are peculiarly concerned with well formed **analogies**, the manipulation of **metaphor** and the **epistemological/psychological/** social problems that attend these pursuits.

"... Cybernetic theories comment upon these **processes**, which are excluded, strictly, from consideration by the run of other sciences, except when viewed from the special perspectives of metaphysics or of **metamathematics**..."

"As a result, all Cybernetics theories are relativistic and some of the more interesting theories are also reflective (becoming "objective" only at specific points, where sharp valued independent **measurement** is possible). For example, with my psychological hat on, but still retaining a Cybernetic orientation, I insist upon *dealing with consciousness*, not *excluding it* (hence, with **self-referential** and other referential systems).

"... I am prone to regard the use of **information** measures and statistical accounts as only one (quite useful) way of dealing with the **situation**. Since such **methods** are apt to objectify the **phenomena**, I think they are somewhat overrated. The chief hazard, is the temptation to use appeals to "**complexity**" as an excuse for *not* tackling the real issue of "reflective" theories and their interpretation.

"... Amongst the more important growing points are: a) Theory of reproductive **automata**... b) The theory of metagames... c) **Fuzzy logics** and concurrent computation... d) Categorical algebras... e) Aspects of **topology**... able to accomodate or represent knowable relations and cultural **patterns**" (1973, p.5).

As to **Artificial Intelligence**, in PASK's opinion: "Perhaps the subject should be called "General Intellect" instead of **Artificial Intelligence**" (Ibid). As early as 1973, PASK perceived that the *process of learning* was of paramount importance and that it was not possible to limit the subject to "... the clever application of **problem solving techniques**" (Ibid).

According to F. ROBB, general cybernetics includes:

- **Conversation theory** (G. PASK)
- **Autopoiesis** (MATURANA and VARELA)
- **Deviation amplifying mutual causal processes** (M. MARUYAMA) (see also **2nd cybernetics**)
- **Self-organizing systems** (I. PRIGOGINE)
- **Self-steering systems**
- **Meta-system theory** (J. van Gigh)

which ROBB considers as "much intermingled streams of cybernetic thought" (1989, p. 51).

Of course, none of these concepts and theory can ignore the original basic **concepts of feedback, regulation and control**.

0792

CYBERSEMIOTICS¹⁾³⁾

A synthesis of systems theory, **second order cybernetics** and the **semiotics** of Charles S. PEIRCE (N. ORT, 2001, p. 155)

The concept has been introduced by S. BRIER (1995, p.3-14). It is closely related to biological and particularly human **communication** because:

- only organized entities (i.e. systems) are able to communicate
- **communication** needs of reciprocal **observation** in a **recursive** way
- elaborated **meanings** appear only through recurrent dialogue among living **observers**
- **signs** and **signals** are the "commodities" traded through communication, which would be impossible without this type of "currency".

BRIER writes: "Cyber-semiotics is based on different view of what a **sign** – and more specifically a **symbol** – is than the **syntactic denotative** concept of cognitive science. It is based on PEIRCE's **semiotics**" (p.6). Formerly "the mechanistic idea of reason and **knowledge** – and of **logic**, of course - has led to a simplistic understanding of how **meaning** functions in both **language** and practice. The mechanist hopes that the **causal interaction of symbols** can be explained through their **syntactic relations**" (p.5). Of course this implies **communication** without the bio-neuro-psychological presence of the **communicators**.

BRIER writes, refering himself to a text of FODOR which basically endorses the mechanist view as expressed through the recourse to purely **syntactic relations**: "There are many arguments against this. Mine are from a biological perspective. I do not think that meaning can be fully represented in a **syntactic logical** form. Meaning is very much tied to biological existence. Two important aspects of this are the dynamics of biological **organization** in relation both to **evolution** and to the **dynamics of population**. The new concepts developed within **second-order cybernetics** and **bio-semiotics**, which describe these qualities, are **autopoiesis** and **code-duality**. In this paper I want to suggest a combination of these including a semiotic approach. This what I call cyber-semiotics" (p.6).

Thus, cyber-semiotics should be understood as cyber-bio-semiotics, in which the "cyber-" aspect should not be reduced to the purely mechanistic **feedbacks** of Wienerian original cybernetics.

0793

CYBERSPACE⁵⁾

"A virtual multidimensional world created and functioning through computers connected within a large **network**" (M. BENEDIKT)

BENEDIKT writes: "Every workstation within is a window open into a world wherein distances are annulated. **Objects** seen or heard are not physical, nor even **representations** of physical **objects**. They should better be viewed as pure **data**, as a kind of raw **information**".

We are thus on our way towards a cybernetic culture, shared by all people who will, in a connected way, become users of the globally connected cyberspace which seems in the making. The consequences for future **human systems** are difficult to evaluate, but could be impressive.

0794

CYCLE^{1) - 2)}

A curve characterizing a sequence of **states** more or less periodically repeated by the system.

G. WEINBERG states: "Cycles are the signature of **state-determined behavior**. When we see a system in a **cycle**, we suspect that it may be at present uninfluenced by external factors" (1975, p.204). These cycles should be of **autopoietic** nature, i.e. a result of the self-regeneration power of the system. However, WEINBERG also admits that the system "...may be influenced by a cyclic external factor, or by an external factor that is too small to break the cycle" (Ibid).

Considered along the **time** dimension, the cycle appears as a sinusoidal **wave** with defined **period** and **amplitude**, more or less deformed by interferences or **perturbations**.

Cycles of various **periodicity** may affect a same **complex phenomenon** and eventually produce a quite irregular curve whose lecture and interpretation become very intricate. **Spectral** (also called sometimes harmonic, or **FOURIER**) **analysis** may be used as a mathematical technique to disentangle such complex curves. It should however be used carefully, because it may very well lead to the appearance of **pseudo-cycles** without any factual bases. This problem unfortunately discredited cycle theories among unaware economists, as signaled by K. BOULDING (1972).

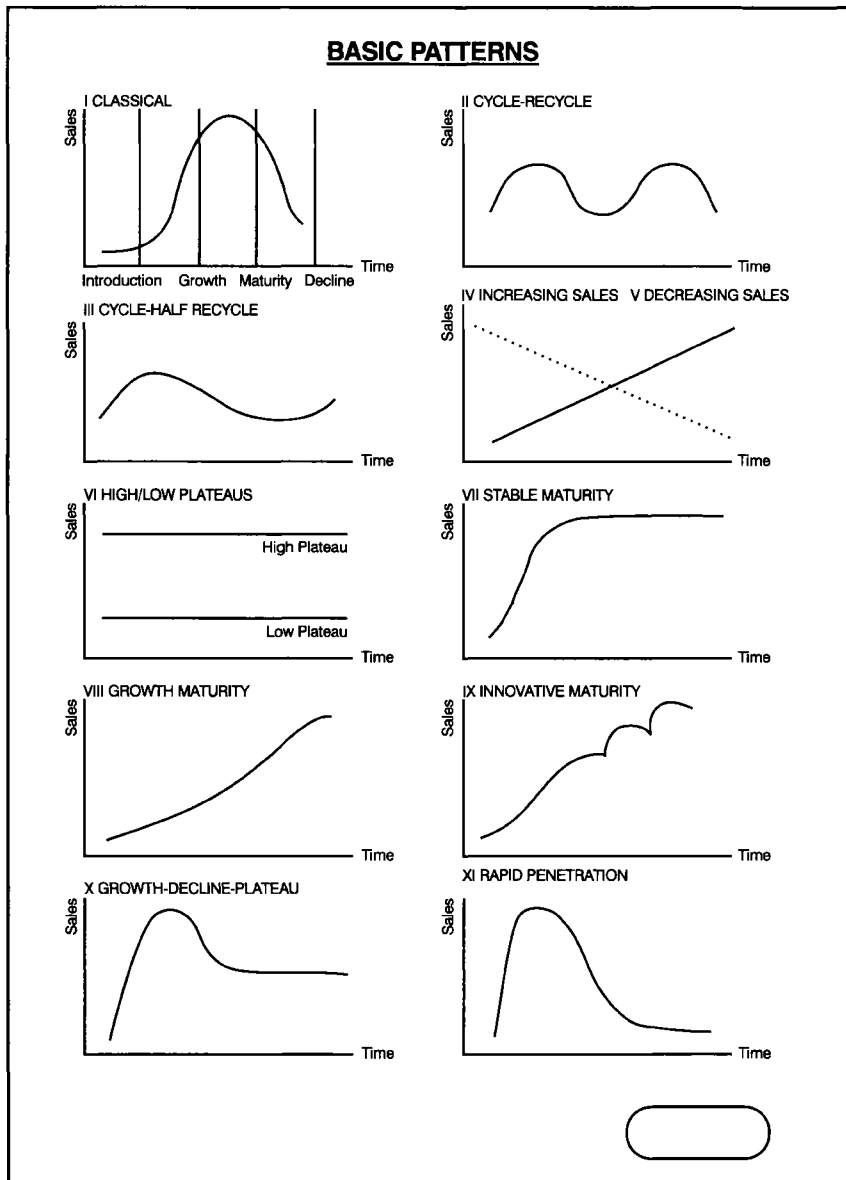
Only **steady states systems** cover this kind of periodical **trajectories** over and over.

The main initial proponents of cycles have been the economists. Proposed economic cycles have been, as recapitulated by K. DE GREENE:

"... the KITCHIN, or business cycle, per se, of three-to-four or four-to-seven years' duration,

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Figure: see entry **CYCLE**



Cycles (Life):

From G. R. DOWLING & J. A. COOPER: 1989, p. 294

interpreted as indicating **fluctuations** in commodity inventories and employment.

"... in corresponding terms, many recognize the JUGLAR cycle of 8-10 years, representing fixed capital in the durable equipment of production;

"the KUZNETS cycle of 15-25 years, representing fixed capital in **structures** or real estate and the mix of capital and labor;

"and the KONDRATIEV cycle or **long wave** of about 45-60 years..." (1988, p.281)

DE GREENE gives very interesting precisions about the characteristics and probable causes of these four cycles. He however observes that "... confusion can arise from regarding "cyclical" as synonymous with "periodic". The intervals between "crises" are not regular; what is regular is the recurrence of prosperity, recession,

depression and revival, in that order" (Ibid).

This confusion discredited the so-called cycles theories. What was not clearly understood is that the four described cycles, together with many others (astronomical, geological, meteorological, ecological, etc...) lead finally to such intricate combinations that it becomes practically impossible to discover regularities sufficient to guarantee some measure of **predictability**. This is closely related to **chaos theory**, which emphasizes the importance of multiple and simultaneous **initial conditions** as the cause of **chaotic determinism**.

This is not to say however that the *quasi-* or *partly* cyclical character of many **phenomena** is an illusion. What remains to be discovered is a practical method to sort out – at least as

much as possible – the intricacies of complex cycles

see table left

0795

CYCLE and STRUCTURE^{1) – 2)}

D. KATZ and R.L. KAHN state that: "The problem of structure, or the relatedness of **parts**, can be observed directly in some physical arrangement of things where the larger unit is physically bounded and its **subparts** are also bounded within the larger structure. But how do we deal with social structures, where physical **boundaries** in this sense do not exist? It was the genius of F.H. ALLPORT (1962) which contributed the answer, namely that the structure is to be found in an interrelated **set of events** which return upon themselves to complete and renew a cycle of **activities**. It is **events** rather than things which are structured, so that social structure is a dynamic rather than a static **concept**" (1969, p.93-4).

The same authors added: "A single cycle of **events** of a self closing character gives us a simple form of structure. But such single cycles can also combine to give a larger structure of **events** or an **event system**. An **event system** may consist of a circle of smaller cycles or hoops, each one of which makes contact with several others" (Ibid).

In fact, any more or less **integrated system** is "social". And all structures disclose recurrent **functions**. They have thus a **synchronic** and a **diachronic** aspect.

These already older ideas heralded altogether the **organizational closure**, **autopoiesis** and **hypercycle** concepts.

0796

CYCLE (Catalytic)

→ Catalysis (self-)

0797

CYCLE (Cumulative)^{1) – 2)}

The progressive development (or **involution**) by reciprocal **feedback** of two or more **functions** or **subsystems** in a system.

According to A. LOTKA, who proposed the **concept**: "The eye and the hand have probably contributed more than any other circumstance to the **evolution** of the human mind up to its present **level**. The possession of an agile member gave opportunity for exercise of the mental faculties, this in turn reacted towards increased development of the tactile sense and manipulative skill of the hand, and so in a cumulative cycle" (1956, p.298).

This author also claims that **language** and thinking have interacted in the same mutual stimulating way.

This would be the equivalent of a virtuous circle. There seems however to exist cases where the reciprocal cumulative cycle has negative effects. It has been conjectured that such is the final effect of progressive gigantism in animal species and in organizations: The economy of scale, positive at the beginning of the process, turns a liability when the problems of internal communication and the cost they cause do finally become overburdening.

0798

CYCLE (Equilibril) ²⁾

According to St. BEER, in an equilibril cycle: "... there are, as it were, a number of competing equilibria, and a stimulus greater than that confluent's threshold can contain will throw the representative point into one of several possible alternative confluents, depending upon the position of the point in the cycle at that time." (1968, p.477).

Equilibril cycles are proper to polystable systems, in which a number of different and alternating behaviors are admitted according to the nature and strength of the inputs received.

The set of alternative confluents (or in topological terminology, "basins of attraction") is however contained into a global vecinity. This means that the system, while adaptable to different environmental conditions, remains however organizationally closed.

0799

CYCLE (Functional) ²⁾ - 5)

J.von UEXKÜLL was one of the first to recognize the existence of functional cycles (1928, reed. 1979), which became later on one of the most significant cybernetic models.

He recognized them as "indivisible wholes" (p.295) and established even a diagram of the regulation device, in which he recognized: 1) the reciprocal and cyclical action of the observer and the object.

2) the main parts of the cycle: the object, the perceptions device, the internal universe of the observer, with its comparing devices, the activating connections and the effector (p.158).

He used this diagram as a model to be applied to biological behavior and ethology, but its very general character is obvious.

0800

CYCLE, in a network ²⁾

"The updating loop in a synchronous interactive network" (W. BECHTEL & A. ABRAHAMSEN, 1991, p.305)

The authors add: "One presentation of an input pattern results in multiple cycles of processing during which the activations dynamically interact until the network relaxes in a stable state (a state in which the input to any unit does not change the probability of activation of the unit) (p.305)

The general behavior of the network is thus quite similar to ASHBY's homeostat's behavior.

The authors also observe that "Cycles, which involve computation of activations, should not be confused with training epochs, which involve computation of weights" (p.306). In this last case, the strength of the connection between two units (also called nodes) is modified.

0801

CYCLE (Inclusion) ²⁾

A higher level cycle, superposed on lesser levels ones, that acts as a general process regulator (see fig.)

This model has been introduced by K. STEINBUCH (1974, p. 112). It gives a quite clear understanding of J.van GIGCH's control by recursion.

This very general model can be observed in many behavioral situations.

see figure below

Figure: see entry Cycle (Inclusion)

0802

CYCLE (Internal) ¹⁾ - 2) - 5)

Elaboration and self-consumption of products within a system.

Many complex systems elaborate products for their own internal use.

H. ODUM gives the example of the photosynthetic production, which is generally measured as a flow between producers and consumers. However, as stated by ODUM: "The actual gross photosynthetic process is much greater than can be measured in this way, because there is fast internal cycling (making and using) in the day stimulated by photorespiration and by the impetus of storages in the various sites of reaction in the cells of the plants" (1971. p.50).

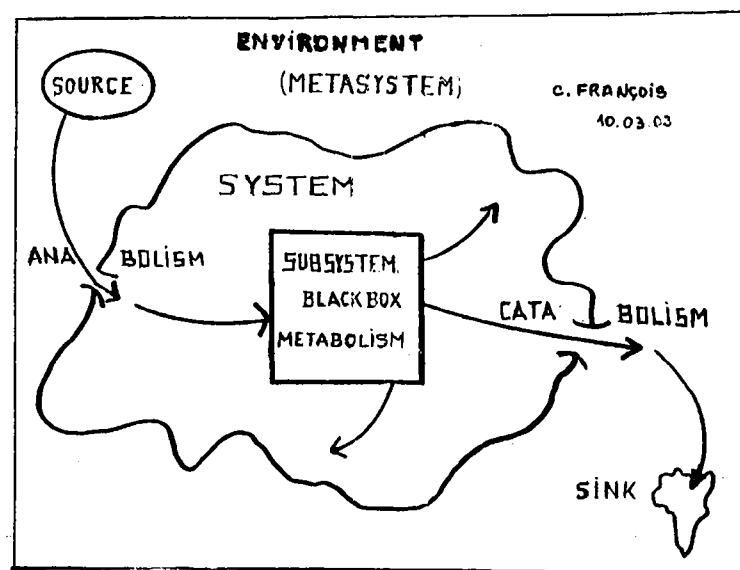
The same kind of erroneous evaluation results of the computing in strict terms of monetarised exchange the gross product of archaic peasants communities: what they produce for their own use is not taken in account.

0803

CYCLE (Life) ¹⁾ - 2)

K. BOULDING states: "It is evident from the study of organizations of all kinds that they exhibit periods of growth, of relative stability and of decay" (1952, p.39).

This characteristic seems to be very general and affects practically any complex system, be it physical, biological, ecological, economic or social. Its deepest causes are still quite obscure, but are probably related to the 2nd Prin-

THE INCLUSION CYCLE

- The system is included in a specific environment
- The subsystem, or subsystems are included within the system, which is their environment
- Optimally, the environment recycles the outputs of the systems or subsystems and the input sources are replenished

ciple of thermodynamics. Since any system, to organize itself, must separate from its **environment**, it thus acquires a limited and precisely defined **level of organization**. This **level** is created by way of a basic **template**, also limited, and thus progressively reaching **saturation**, i.e. unable to maintain a sufficient **adaptability** (which should be carefully distinguished from the antinomic **adaptation**, which is a stabilized and limited collection of possible **states**).

A typology of life cycles **patterns** can be helpful in the study of **growth** and **decay processes**. The following can be distinguished:

- **normal**: Accelerating **growth** followed by decelerating **growth**, reaching a maximum and thereafter accelerating **decay** followed by slower **decay** until the end of the **process**.
- **linear**: regular arithmetic **growth**, theoretically – while not practically – unlimited in **time**.
- **exponential**: permanently accelerating **growth** (through some **positive feedback**, for instance), also theoretically unlimited in **time**.
- **asymptotic**: progressively decelerating when nearing maturity and tending to a defined upper **limit**.
- **logistic**: Accelerating **growth** followed by deceleration, but thereafter tending to asymptotic.
- **oscillating**: characterized by a series of **growth** and decrease, **periodic** or aperiodic **phases**.
- **embedded**: the cycle is limited by the **patterns** of a higher **level** cycle of longer **periodicity** and greater **amplitude**. Various **levels** of **embedment** are possible.

Numerous combinations of the forementioned **patterns** can be encountered, as for instance:

- **oscillations** may appear within a general **long term trend**, which itself can be of one or another basic type. An example are WADINGTON's **chreods**.
- innovative **spurts** may prolong the cycle, delaying final **decay** for some **time**.
- **decay** can be interrupted by **stabilization** at an intermediate **level** (plateau).

0804

CYCLE (Limit) ²⁾

A closed cycle characterized by the periodic repetition of given **trajectories** in a **dynamically stable** system.

Limit cycles were first described by H. POINCARÉ and are now known better known as **cyclical attractors**.

J. CRUTCHFIELD et al state that: "A limit cycle describes stable **oscillations**, such as the motion of a pendulum clock and the beating of a heart" (1989, p.42).

A stable limit cycle corresponds to a **domain of attraction** and, in topological **models**, to a **basin**.

A **trajectory** or system may leap out of its limit cycle (**switching**) under the impact of some strong **perturbation**. A recent example has been the destruction of comet SHUMAKER – LEVY 9, whose orbit was heavily perturbed by Jupiter.

→ **Limit cycle**

0805

CYCLE (Recurrent) ²⁾

According to W.R. ASHBY: "If a **line of behavior** is re-entrant to itself, the system undergoes a **recurrent cycle**" (1960, p.49).

However, if the cycle is submitted to a non-compensated **positive feedback**, an **instability threshold** will eventually be crossed and a **runaway process** will be triggered, leading in most cases to the destruction of the system.

0806

CYCLE (Stable) ²⁾

After defining what is a **recurrent cycle**, ASHBY states that: "If the cycle is wholly contained in a given **region**, and the **lines of behavior** lead into the cycle, the cycle is stable".

ASHBY gives an enlightening example: "Such a cycle is commonly shown by thermostats which, after correcting any gross displacement, settle down to a steady **oscillation**. In such case the **field** will show, not **convergence** to a point but **convergence** to a cycle" (1960, p.49).

0807

CYCLE (Stable limit) ²⁾

"A persistent **pattern** of **endogenously** driven cyclical **behavior** of a system" (T.F.H. ALLEN & T.B. STARR 1982, p.278).

0808

CYCLE TIME (Endogenous) ²⁾

"The **time** taken for a system to complete a **cycle** of characteristic **behavior**" (T.F.H. ALLEN & T.B. STARR, 1982, p.267)

ALLEN and STARR give as an example a single heartbeat and they comment: "The **endogenous** cycle time determines the **time** taken for a **holon** to return to its **equilibrium behavior** after being influenced by an external **signal**. This is sometimes called the **relaxation time**, an alternative **criterion** for arranging **holons** in **hierarchies**" (p.37).

0809

CYCLES (Pseudo-) ²⁾

K. BOULDING observed that the mechanical use of **spectral analysis** is: "...an elegant way of detecting probably nonexistent cycles and

throws no light on the real **structures** and **processes** which underlie **fluctuations**" (1972, p.86).

In other words, the results of **spectral analysis** of curves must be validated. The subject is quite difficult in the study of the **behavior** of **nonlinear** systems, when various periodic **functions** of different **periods** and **amplitudes** do reciprocally interfere.

0810

CYCLIC ORDER ²⁾

The periodic reappearance of some sequence of **activity** in some behavioral **pattern**.

The classical example are the periodic fluctuations in the Belousov-Zhabotinskii **reaction**. (A. WINFREE, 1980).

This type of repetitive **patterns** is however very general in **self-organizing structures**. B.F. MADORE and W.L. FREEDMAN demonstrate as much by computer **simulations** (1987, p.252).

According to them: "All that is required for our simulated chemistry experiment is a mix of "**elements**" which react in such a way that they will be found sequentially in one of three main **states** (active, receptive and quiescent); that these **states** occur in a cyclic order; and that there are a few simple **rules** as to how one **state** leads to the next".

And "... the first basic **forms** found in these experiments - the rotating **spirals** and expanding closed **circles** - are **topologically** related. Once the **circles** are explained the **spirals** are, in fact, a natural (expected) consequence" (p.254).

"Interestingly, the computer **model** does not involve any chemistry per se; it works with only a set of "**allowed states**" and a set of **rules** for the **interaction** and **transition** between **states**" (p.255-6). It is fact a **cellular automaton**.

The subject is closely related to J. CONWAY's **Game of Life**, to I. PRIGOGINE's models of the **emergence of order** through **bifurcation** and **nucleation**; to Ch. LAVILLE's **vortexes** and to D. Mc NEIL's **toroids**.

0811

CYCLICAL or PERIODIC ? ¹⁾

K.DE GREENE warns: "... confusion can arise from regarding "cyclical" as synonymous with "periodic" (1988, p.283).

Periodicity supposes a clearly defined **frequency**, normally combined with an also well defined **amplitude**. Periodic curves are sine **waves**, ideally perfect ones. But perfect **periodicity** supposes the also perfect **stability** of **environmental** conditions, whether in astronomy or in economy.

Such a **situation** is merely an abstract scheme, which explains the general failure of purely formal **forecasting**.

In real **situations** we witness numerous combinations between cycles of very different **frequencies** and **amplitudes**.

Some cases are more or less manageable, when one of the superposed cycles is strongly dominant. These **situations** have precisely been those which gave rise to the general idea of cycle. **Populations ecology**, for example, offers such cases

However, this is exceptional. The normal case is the superposition of various, or even numerous cycles of different **frequencies** and **amplitudes**, some of these quite comparable, others covering widely different **time spans**.

The composition of such a **variety** of characteristics yields normally curves that seem completely irregular, with **unpredictable** and sudden **changes** of orientations. (so-called **chaos situations**) A very good example is given by the stock market vagaries.

There are however some intermediate **situations** which look more promising:

1. When the respective **frequencies** are commensurable, even in the case when one **period** is so very much longer than the other or others that it may escape **observation** and analysis.
2. When the respective **frequencies** are incommensurable, but covering not excessive **spans** of **time** as to be still practically observable. In such cases, the complete cycle corresponds to the least common multiple of the **frequencies**. For example, a complex cycle of 1547 years would be the result of three interfering cycles of 7, 13 and 17 years.

However, the practical problem is quite intractable, because the detection of any regularities demands to begin with, a large series of **observations** of a generally confuse type of **situations**, covering a very long **span** of **time**.

Nevertheless, the concepts of periods **embedment**, of **renormalization**, of **fractalization** and of **deterministic chaos** may be of some help in the future.

→ **Self-similarity** in the **WEIERSTRASS** function.

0812

CYCLICITY

→ **Organization: a descriptive language**

0813

CYCLING RECEPTOR (or module)²⁾

A section of an **energy network** where an **input** of **energy** is used to motor an on and off **action** and then passed along downstreams in the **network**.

H. ODUM who introduces this **model** writes: "In this module **energy** interacts with some cycling material producing an **energy-activated state**, which then returns to its desactivated **state**, passing **energy** on to the next step in a

chain of **processes**. The kinetics of this module was first discovered in a reaction of an enzyme with its **substrate** and is called a MICHAELIS – MENTON reaction" (1971, p.39).

0814

CYCLOGENESIS^{1) – 2)}

Self-organization of the various functional **rhythms** in a system during the **process** of its **morphogenesis**.

0815

CYCLOMORPHIC^{1) – 2)}

Character of a **process** that seems to show irregular or imperfect **cyclical behavior**.

This corresponds to the practical situation in **concrete systems**, whose **periodic behavior** is submitted to numerous **endogenous** and/or **exogenous perturbations**. Interferences between **cycles** of different nature within a **complex system** may also lead to a global cyclo-morphic character, closely similar to **chaos**. Some of these – but not all – may themselves be **cyclical** or cyclomorphic. This explains why **cyclical models**, even **cross-level embedded** complex ones, are practically never entirely satisfying. It does not however mean that they are useless: fuzzy **predictability** is better than total **unpredictability**.

D

0816

DAMPING²⁾

A check on **fluctuations** in a system.

Damping is generally the result of **regulation** by a **negative feedback** which impedes excessive **fluctuations**.

When giant **fluctuations** set in, the damping capability of the system is strongly reduced, **instability** surges, a **bifurcation** (or **catastrophe**) may occur and **chaos** may eventually set in, or a system of higher **complexity** may emerge.

Damping may also result from a limiting influence exerted by **environmental** conditions through the **boundary** of the system.

K.De GREENE observes: "Damping increases with increase in surface/volume ratio or **interface zone** and stems from **interactions** on the **boundaries** of the **fluctuation region**" (1988, p.291).

0817

DATA^{3) – 5)}

Any **elements** of **information**.

G. BATESON observes: "... "data" are not **events** or **objects** but always records or **descriptions** or **memories** of **events** or **objects**.

Always there is a **transformation** or recoding of the raw **event** which intervenes between the scientist and his **object**" (1973, p.24).

This is true not only for the scientist, but also for any human being. Moreover, the **transformation** is at least physical and physiological and, as stated again by BATESON: "... always and inevitably, there is a **selection** of data because the total **universe**, past and present, is not subject to **observation** from any given **observer's** position... (and) no data are truly **raw**, and every record has been somehow subjected to editing and **transformation** either by man or by his instruments" (Ibid).

It could be added that data make sense only in **contexts**, acquiring different shades of **meaning** in different **reference frames**.

From another angle, the meaning of the word has been subtly changed since the advent of computers. In computers, data are not only collected, but also organized in order to be retrievable according to need for **information** treatment. As observed by W. REEVES: "Data is the specially designated electronic machine version of **information**. It has some **structure**, it may be true or not. It is not a **process**, but it does have the potential to render a **meaning** in the human **observer**. It lacks the human to human **connection**, but what is stored as data can only exist from human intervention either as **input** or **algorithm**" (1992, p.1100).

0818

DATA ANALYSIS²⁾

T. BAUMGARTNER et al. state: "A major task of data analysis is to assist in the **choice** between alternative **models**. The question arises then, under what conditions would the analysis of empirical data suggest a **multilevel** system" (1976, p.36).

Besides, different possible uses of the data may imply a **choice** between different **models** to organize them. A very general problem arises from the frequent necessity to use short or very short series of data to integrate a would be **long-term model**, in order to obtain some **forecasting** power. As shown by the Italian demographers C. GINI (1952, p.81-92) and C. CIPOLLA (1973, p.63-70), imprudent **extrapolation** can lead to quite absurd **forecasts**: A seemingly **exponential growth** at **short term** may very well be a **logistic growth** (or asymptotic, or other) when, later on, some **control** factors become more effective and visible.

We now moreover know that some **processes** are **chaotic**, which adds a new type of difficulty to select a really **fitting model** for data **integration**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0819

DATA (Analysis of time-series)²⁾

K.De GREENE states that there are many difficulties associated with analysis of time-series data related to **complex systems**, as "... for example, the absence of spottiness of data, appropriate data in particular and the **aggregate nature of data**" (1988, p.288).

Moreover, when applied to complex **cycles** research: "Methods of averaging and filtering, including the **selection** of moving averages to eliminate the masking higher-**frequency fluctuations**, tend to be subjective and may produce distorted results... two kinds of errors can occur: missing the existence of a **cycle** or **wave** when it really exist, and reporting a **cycle** or **wave** when none exist (the so-called SLUTSKY effect)" (ibid).

These are the problems of practical use of **FOURIER (harmonic) analysis**. In a different form they also appear in the **design** of systems in FORRESTER's **systems dynamics**.

0820

DATA REDUCTION²⁾

"A **process** of data summary achieved by any of a large number of methods of multivariate analysis" (T.F.H. ALLEN & T.B. STARR, 1982, p.265).

ALLEN & STARR remark: "After reduction, a large and complex data set may be represented approximately through expressing **interrelationships** between **observations** either by placement on a small number of axes or by grouping them together in a series of discrete **classes**" (ibid).

Of course, the **selection** of the reduction **model** is subservient to the **objectives** of the modelizer.

0821

DECAY^{1) - 4)}

The progressive degradation, disorganization of a system.

Decay is generally due to a non-compensated **negative feedback**, which progressively dampens the **resilience** of the system, i.e. its capacity to adaptively fluctuate within a not too narrow band of **values** or **situations**.

It also can result of the depletion of critical **elements** in the system.

Decay is somehow associated with **ageing** in **living systems** and also with clogging by excessive **accumulation** of some **types of elements** or residues, which poisons the system.

It is also related to the progressive loss of **redundancy**, and **saturation** of **information channels** in **social systems**.

In interactive **parallel processing networks**, decay refers to a decrease of **activity** in the **network**, i.e. a decrease of the number of **activation events** in function of **time**.

0822

DECIDER^{2) - 4)}

"The executive **subsystem** which receives **information inputs** from all other **subsystems** and transmits to them **information outputs** for **guidance**, **coordination** and **control** of the system" (J. MILLER, 1978, p.3).

The decider is one of the **20 critical subsystems** in J. MILLER's **taxonomy of living systems**. In **complex systems**, there are generally deciders at every **level**, responsible for their own **level** and sublevels

0823

DECISION^{1) - 4)}

"Logical **operation** enabling an **autonomous system** to act in order to reach some **goal**" (M. BELIS, 1987, p.57).

According to J.Z. YOUNG, decision is "the **process** of choosing between alternative **programs of action**" (1974, p.291). It implies the introduction of new **constraints** in order to limit **choices** and clearly define the chosen alternative. Of course, alternatives should be clear and, as decision is generally related to the **management** of systems, which require global **understanding** of complex **situations**, the **systems approach** is a basic tool

M. BELIS comments her definition: "This is proper to **cybernetic systems**, which are finalized **autonomous systems**" (ibid).

Capacity of decision is an aspect of **autonomy** in P. VENDRYES sense, i.e. the ability of a system to **regulate** and **control** its internal **states** (1989, p.147).

Some systemists speak of a "decision science" which should explore the conditions of **decision making**. Considering the multiple historical and cultural differences, as well as the widely different **situations** that condition **decision making**, constructing such a science would be a considerable challenge.

0824

DECISION CONTEXT¹⁾

The **set** of the internal or external **constraints** bearing on the system or **situation** object of the decision making **process**.

As stated by M. TODA: "... the more stringent the total **constraints**, the narrower the sphere of possible plans" (1976, p.83).

As in any evolving **situation** the decision context may vary, its permanent **observation** is required in order to update the decisions when necessary.

0825

DECISION HIERARCHY²⁾

An **embedded set** of decision **processes** of wider and wider scope from lower to higher **levels**.

M. TODA states: "(a) given decision problem may be a **nested** one within a grander decision problem which is **nested** within a further grander decision problem and so on. Formally, therefore any decision problem is situated within an infinitely **self-embedded** hierarchy of decision problems, which shall be referred to as the decision hierarchy" (1976, p.80).

It is however difficult to see why the decision hierarchy should be infinite. ("The buck stops here"!)

0826

DECISION MAKING^{1) - 4)}

"A thinking **process** which pervades all problem-solving **activities**" (J.van GIGCH, 1978, p.81).

"**Iterative** thinking at the basis of **Systems Design Process** by which plans are made and alternatives chosen for implementation" (J.van GIGCH, 1978, p.589).

van GIGCH states: "Decision making is a term sometimes reserved for the **action** of making a **choice** among alternatives. This is a narrow interpretation of the **concept**" (p.81). van GIGCH broadens considerably the scope of decision making and shows that a good **knowledge of context** and **context of context** is an important factor for reaching sound decisions. His very developed arguments unfortunately cannot be satisfactorily resumed here (see chapter 4 of his book).

E.J. KROWITZ, in accordance with H. SIMON principles of decision making, states the necessity to cling to "**choice of bounded rationality**", which implies "a decision **process** by which policies are selected that may not be optimal but are not inconsistent with important system **constraints**" (1991, p.48).

However, as observed by K.DE GREENE: "In decision making **situations** an unwarranted degree of **rationality** and **optimality** are often assumed" (1990, p.51). Uncertainties, for example, can be formally acknowledged, but their real scope actually ignored. And the use of terms like "satisfactory, adequate, useful" and the like frequently occult subjective and/or self-interested valuations.

On the other hand, **models** used in decision-making are generally based on implicit **assumptions** and biases about the nature and the actual **dynamics** of the system (for instance, trying to merely re-establish **stability** in **situations** of irreversible **change**), not to speak of the possible deformations resulting of the formalization **process** itself.

Moreover, one of the main problems of the decision maker is to discover *all* the important **constraints**, many of which, as observed by J.van GIGCH, originate in the **metasystem**.

A very serious problem affecting decision-making is denounced by M. DODDS: "... human **values** are relegated to an inferior status and a **variable** to be discounted in rational **planning**

and decision-making, the rational concern being with feasibility, with "given **means**" and with their **optimisation** in every **context**. Operationalized as "development policy", we have seen how it failed in the Third World", and in the guise of "shock therapy", we see the effects in the former Soviet Union and Eastern Europe where the entire cultural **configuration** of a society is not taken in account" (1994, p.1419). Obviously, the **problem** behind this **problem** is the lack of a practical **method** to generated a wide, satisfactory and sufficiently fast **consensus** of all **stakeholders** in critical **situations**. This is a **double-bind** case: Some really sound **changes** are impossible without democratic **consensus**... but cannot be postponed until all **stakeholders** can acquire the necessary **knowledge**, **understanding** and sense of personal responsibility.

M. DODDS herself recognizes this, at least implicitly: "The separation of authority and responsibility, and the separate **optimization** of societal **functions** creates structural **conflict** between different **functions** as well as between government and civil society" (Ibid). Still, where is the short cut we need: *Enlightened co-participative design* is possible within limited groups, but how to generalize it for thousand or millions of participants (generally anxious for swift **change**, ill-informed about real possibilities and frequently manipulated by groups of "hidden persuaders")?

I.I. MITROFF and H.A. LINSTONE, using their **Multiple Perspective Concept**, observe that the "Organizational or Societal Perspective" is much better understood in China: "Chinese culture is bureaucratic and hierarchical so that Organizational **games** and **strategies** are generally known to everyone.... (However), Personal perspectives present more of a hurdle" (1993, p.107).

0827

DECISION- MAKING STRATEGIES ⁴⁾

Most of decision-making strategies are more or less **reductionist**. As noted by T.R. BURNS and L.D. MEEKER: "This strategy eliminates problems of having to **process** and deal with different **evaluations**, at least in most phases of decision- making. Above all, it enables **conflicts** between different **goals** or evaluative standards in concrete settings to be articulated in relatable terms and resolved within an unidimensional **value** framework... Internal **complexity** of the decision-making system is reduced in order to achieve greater or easier computability and decidability, but this may be at the expense of essential representability of external **complexity** and effective **action** in a complex **environment**" (1976, p.112-3).

This could be good enough in simple **situations**.

However, **situations** may not be as simple as they seem... and the decision-maker may not be aware of it.

In order to allow for more secure **evaluations** prior to **action**, a systemic strategy should carefully consider the relations of the system with its **metasystem** (van GIGCH), in order to discover if some of these have some significant – and possibly ignored – bearings on the system's **behavior**.

It should also consider its internal **organization**, in terms of **network relationships** and **organizational closure**, since some unknown **self-referrent behavioral cycle** may react to some decisions by possibly uncontrollable blockages or **runaway processes**.

Still another, and quite subtle problem is the possible **incompatibility** between **multiple objectives**, which could be partial or total, or a result of an erroneous **understanding** of the relations between different **time scales**.

This should be addressed by a better systemic **understanding** of the potential **availability** of **resources**, the need for **regulations** and the possible differential **cyclical behavior** of some **variables**.

In very complex systems, decision-making should ideally be a final result of wide participation of all the **stakeholders**.

→ **Design (Co-participative); Design (Generic)**

0828

DECISION PROCESS ^{1) - 4)}

The sequence "of all the **subprocesses** pertaining to the **selection** of a course of **action**, or a plan, and its execution" (M. TODA, 1976, p.79).

TODA observes: "Most of these **subprocesses** except some well formalized ones like decision analysis, are covert processes taking place exclusively in somebody's mind, and are hitherto paid relatively little attention" (Ibid).

Taking a decision is the **end** of a frequently long and complex process.

It also is, in many cases, an **embedded part** of a more global ongoing one.

As to the first aspect, the **decider** needs **information** about the **situation** which requires the decision. This implies an **inquiry**, generally in order to obtain a better evaluation of an **ill-structured problem**. The results of such an **inquiry** mostly depends on the acumen of the decision-maker (or his/her assistants) in selecting the relevant **data** within the relevant **frame** and in converting them into the adequate **information**.

An important aspect of this search process is a correct **evaluation** of the more general conditioning factors, i.e. the evaluation of the **model** of the **situation** within a **meta-model** in which seemingly irrelevant factors may suddenly emerge as fundamental.

A good definition of the **goals** may also be difficult, because they can be **fuzzy**, or complex and in need to be compatibilized or serialized.

Once the **goal** is defined, it generally can be reached only through an **ordered sequence** of decisions, each one at its proper **time**.

Finally, no process escapes from possible unforeseen **disturbances** in the **environment**. It must thus be reconsidered frequently and this may lead to **changes** in the **evaluation** of the **situation** and in the **sequence** of decisions.

Decision process with or without disadvantage compensation

M. MARUYAMA observes that most decision processes leave dissenting or damaged minorities "in the cold". He writes: "It is commonly considered "democratic" to make decisions by voting, in which a majority wins. The majority preference is justified and legalized, and minorities are put at a disadvantage and forgotten. This false concept of democracy is the cause of the current trend of division of countries into smaller countries" (1994, p.40).

This very general cause of strife, sabotage, secession and **conflict** is also verified in many lesser **organizations**: enterprises, political parties, churches, civic **groups**, etc.

MARUYAMA gives examples of disadvantage compensations and shows how they could be provided, in order to maintain internal harmony in **human systems**.

0829

DECISION PROCESS (Delayed) ^{1) - 4)}

A process in a complex system by which decisions are taken only after extensive recirculation of the available **information**.

In such processes the **feedback** of the available **information** among the **elements** or members of the system allows **time** for the progressive **ultrastabilization** of the system, centering the decisions to be taken towards the **optimum**.

Such a process can be modeled by **attractors**.

This cooperative **behavior** seems to be a characteristic of widely different types of systems, as for example:

- The search for the location of a new beehive by swarming bees (T. SEELEY, 1989).
- The cooperative **learning** process by neurons in the **brain** (L. PERSONNAZ et al., 1988).
- The **recursive method** for decision making in Japanese firms.

0830

DECISION SCOPE ^{2) - 4)}

The all-embracing area that must be covered by the **decision process**.

M. TODA describes it as follows: "The background **field** upon which the **decision tree** lies, defined jointly by the preselected plans, the horizon and the **structure** of the tree **network** produced by the **hierarchical organization** of the decision will be called the decision scope" (1976, p.81).

0831

DECISION THEORY ^{1) - 3)}

"The corpus of theoretical **knowledge** which bears on the **process** of reaching the best decision" (after S. BEER, 1968, p.211).

This corpus is now enormous and quite dismembered, since it has been considered from numerous and varied viewpoints by many authors. However, BEER's cybernetic and systemic 1968 treaty on "Decision and Control" remains a most important source on the cybernetic-systemic decision theory.

According to M. BELIS: "The decision theory aims at the establishment of a rational base for **action** in **uncertainty**. It is a normative theory as it elaborates the **rules** along which a rational **decision making** system (human or technical) should operate in order to reach its **goal**. It is also a descriptive theory which tries to discover and formalize those **algorithms** used by human beings when facing **uncertainty**."

"When facing a decision problem, the system must choose a **response** (or an **action**) in order to maximize a **performance** index. The interference of the **response** with the **environment** generates an **event**, namely the result, whose usefulness is assessed by comparing it with the **goal**."

"The **uncertainties** that may exist in a decision problem are related to the **state** of the **environment**, to the **set** of possible **actions**, to the potential results and their usefulness in relation to the **goal**. The decision system may be short of **information** on one or various of these points. Sometimes **uncertainty** may affect the **goal** itself."

"One of the fundamental, and still not solved, aspects of the decision theory is related to the **algorithm** which should allow us to transform the incomplete and disparate **information** at our disposal in relation to the **states** of the **environment**."

"This leads to question the very fundamentals of the **concept** of probability, which should from now on acquire a broader **meaning**."

"It must be also defined in the cases of isolated (non recurrent) **events** and permit to calculate the numerical value of the apriori probability (i.e. before the experiment) in the general case of unequally possible **events**" (1987, p.57-58).

Decision theory is also concerned with **risk assessment**, **cost** and benefits **evaluation** and programming of the best course to follow in **time** in relation to **resources** presently available or supposed to become available in due time.

0832

DECISION TREE ^{2) - 4)}

The ordered sequence of the decisions taken or to be taken.

"A decision tree is essentially a branched list of questions in which the answer to one question determines the next question asked"

The decision tree is generally represented by a branching **graph**.

Each question is called a "**node**" on the tree, and each answer leads to a separate "**branch**". At the end of each branch lies a "**leaf node**", where the decision tree assigns a **classification** to the **data**" (C.E. BRODLEY et al, 1999, p.57).

Of course, each **node** represents a hypothesis with different conjectures, formulated in accordance with some **assumption** about the **process** under study.

M. TODA describes the decision tree as follows: "Several alternatives courses of **action**, which I shall call plans..., are neatly organized into the form of a decision tree. All the alternative plans branch out from the **node** representing the current decision **situation**. Then each of the plans-branches fans out at a **chance node** over which is assigned a probability **distribution**. Then, at the end of each finger of the fan one will find another subdecision **node** from which subplans branch out further. After repeating these branchings several times, each route will end up at a certain **terminal state**. Utilities are assigned to various locations all over the tree, and also to all the terminal **states**."

"Given the fully worked out decision tree, it is a simple matter of computation to determine which plan produces the highest expected utility, and the end of computation is followed immediately by the moment of deciding" (1976, p.79).

Such a neat – and quite formal – ordering does not however insure in itself the good **fit** of the plan: it merely defines the correct **sequence** to be followed, once a general – and supposedly satisfactory – decision has been taken about the global plan.

0833

DECISIONS (Collective) ⁴⁾

The global results of very numerous individual decisions taken simultaneously.

Of course, the global **effects** observed are nobody's personal responsibility. But, as observed by W. HARMAN, we should seek a way "toward resolution of the fundamental dilemma that the resultant of the microdecisions is so typically an unsatisfactory macrodecision" (1972, p.91). As noted by HARMAN the solution should not depend on Adam SMITH "invisible hand", nor on manipulation by a technocratic elite or by irresponsible bureaucracies. Rather, in HARMAN's words "it depends on re-education to perceive suitable macrodecisions and appropriate microdecisions to lead toward them, and on a shift in cultural values to support the process" (Ibid).

tion to perceive suitable macrodecisions and appropriate microdecisions to lead toward them, and on a shift in cultural values to support the process" (Ibid).

The issue of global pollution, and the global decisions to be taken and applied, in all their **complexity**, is a very good example, among many others.

0834

DECODER ²⁾

"The **subsystem** which alters the **code** of **information input** to it through the **input transducer** or internal **transducer** into a "private" **code** that can be used internally by the system" (J. MILLER, 1978, p.3).

The decoder is one of the **20 critical subsystems** in J. MILLER's **taxonomy of living systems**.

0835

DECODING ²⁾

The **process** of restoring original **messages** from the forms in which they were transmitted, stored or enciphered, by applying a suitable **code**" (K. KRIPPENDORFF, 1986, p.22).

Of course, the **decoder** must know the sender's **code**. Decoding implies two **levels**: 1) the physical coherent restoration of the original **signals** (as in phones of TV sets) and, 2) the correct interpretation of the **symbolic** or **semantic meaning** of the **message**. In all cases, the **code** must be **shared**, even if the final result is a derived interpretation (as for instance in false colors **maps**).

Satisfactory decoding depends at least on the following three conditions:

- The existence of a limited amount of **noise** in the physical **channel**, as to maintain distortions to a minimum at the **receivers** end;
- the physical and physiological capacity of the receiver to pick up the **message**;
- the **knowledge** by the **receiver** of the sender's **semantic** and **syntactic code**.

0836

DECOMPOSABILITY ^{2) - 3)}

Decomposability gives itself in various degrees, corresponding to various **levels**. This has been stated by H. SIMON in the following way: "... **hierarchies** have the property of near-decomposability. Intra-component **linkages** are generally stronger than intercomponent **linkages**. This fact has the effect of separating the high-frequency **dynamics** of a **hierarchy** – involving the internal **structure** of the **components** – from the low frequency **dynamics** – involving **interaction** among **components**" (1965, p.72).

0837

DECOMPOSABLE (Nearly) SYSTEMS²⁾

According to H. SIMON: "At least some kinds of **hierarchic systems** can be approximated successfully as nearly decomposable systems. The main theoretical findings from the approach can be summed up in two propositions:

"a) in a nearly decomposable system, the short run **behavior** of each of the **component subsystems** is approximately independent of the short-run **behavior** of the other **components**.

b) in the long run, the **behavior** of any one of the **components** depends in only an **aggregate** way on the **behavior** of the other **components**" (1965, p.69).

This implies that **complex systems** are, by their nature, **heterogeneous**, i.e. made of different types of **parts**, that can act with some degree of **autonomy**.

However, it means altogether that every **subsystem**, on its own, is strongly coherent, as well as the **complex system** taken as a **whole**.

No **complex system** could survive any of the two following conditions:

a) complete **homogeneization** of its **parts** or **subsystems**

b) total **independence** of the same.

Moreover, the **behavior** of the **parts** may fluctuate in a more or less **random** way, but within the **limits** of local and global **determinisms**.

This is still more so in the case of imperfectly **integrated systems (composite systems)** as for example a **population**.

0838

DECOMPOSITION²⁾

The construction of a **model** of a system in such a way as to conspicuously show its **subsystems** and/or **elements**.

M. TODA and E. SHUFORD state: "For a decomposition to be meaningful, there must be some means to obtain **information** about the **state** of each **subsystem** generated by the decomposition" (1965, p.8).

According to J.van GIGCH, decomposition allows "the decentralization of authority and of tasks" (1978, p.589).

There is a **reductionist** way and a systemic one to build a decomposed **model** of a system.

The first one is mainly interested in the **elements** themselves, because they are supposed to conceal the fundamental nature of the system. A good example is the quest for the basic, ultimate elementary particles in micro-physics.

The systemic decomposition seeks to understand the significant **interrelations** among the **structural-functional parts** of the system, i.e. the **critical subsystems** (In J.G. MILLER's sense).

Both types of decompositions are interesting and useful in their own way. In many cases, they could – and should – be used in a complementary way.

0839

DECONSTRUCTION³⁾

In the epistemological critique of science, an attempt to explore the psychological and sociological roots of the ways scientific **theories** and **models** are established ("constructed").

One of the first steps in this investigation has been Th. KUHN's work on the "Structure of Scientific Revolutions".

From a cybernetic-systemic viewpoint, H.von FOERSTER's comments about "**objectivity**" as "...a **subject's** delusion that observing can be done without him" (1983), led him to his Cybernetics of "**Observing systems**", no doubt, a voluntary **ambiguity** in terms.

von FOERSTER has been moreover an inspirator of H. MATURANA's **autopoiesis** and **organizational closure**, applied to the ways our **brains** construct their own structural **frames** and become somehow limited by their **organizational closure** as to what they are able to observe and the ways they observe it.

It should be however noted that cross-examination by various of von Foerster's "**subjects**" - if not resulting in collective delusion as it occurs sometimes - offers a base for what is generally called "**objectivity**" through compared **observations**.

Anyhow, in C. EMMECHE's words: "**Theories** are never pure copies but always help to constitute the "**objects**" that they connect into a rational **whole**. **Theories** utilize **models** of every kind as **tools**, and these **models** are projected onto the **object's domain** in order to compare the **model's behavior** with that of "**reality**". This applies regardless of whether we are speaking of purely verbal, informal **models**, physical **models**, or formal **models** that can eventually be simulated" (1994, p.162).

It is noteworthy to see EMMECHE put "**reality**" within quotation marks.

This way to question the "reality of reality" is in fact only a way to question our effective capacity to know **reality** - without quotation marks - "as it is", with quotation marks!.

This led however to a very strong reaction from physicists, as A. SOKAL and J. BRICMONT, who cannot admit that any description of reality is as valuable as any other, and can be left to the whims of self-appointed philosophers of science (1997). They seem to be at least partly right on both points: it is obvious - even pragmatically - that NEWTON's physics operativity speaks well for its value as a **representation of reality**, whatever this intrinsically means.

...However, EINSTEIN - two centuries later - proposed a wider **representation**, which did not disprove Newtonian mechanics, but proved still more operative in embracing a wider section of **reality**. In both case, these **representations** had to be finally admitted by **consensus** (i.e. in some cases a very deep **paradigmatic change** at the psycho-social level of the scientific establishment - KUHN!).

Of course, it would be unreasonable to doubt that science obtains in its progress more and more efficient (better and better?!) **representations of reality**. But we can never be sure that its most recent word is the last and uncontradictable word (as noted by POPPER).

All this boils down to the constant necessity to maintain a critical view, not so much about **reality** as of ourselves as "**observing systems**". After all, SOKAL and BRICMONT too are **observers**, construct **theories**, or adhere to **theories** constructed by their colleagues.

Very recently, a quite sharp turn can be observed in the ways scientific **models** and **theories** could be constructed.

Just as during the recent centuries the progress of scientific instruments became a motor of our changing view of **reality**, it seems that we are again on the edge of a wholly new way to create **models** and **theories**: by computer **simulation**.

EMMECHE, for instance, observes that we are entering the era of **bio-logics** through the construction of computer **models** of biological **behavior** (Ibid, p.163). A program is constructed with **rules** that are hypothesized to govern some specific biological **behavior** and the results of **simulation** induces us to confirm or discard our preconceived views: a fine way for observing "**observing systems**", as **observers**.

This could be considered a kind of incipient scientific **constructivism**.

→ **Derealization; Model building; Model making; Model validation; Ontological skepticism or agnosticism; Realism; Reality**

0840

DEDUCTION³⁾

A rigorously logical thought **process** that consist in reaching a conclusion in a specific **issue**, based on precisely stated general principles.

The classical example is: "Men are mortal. Socrates is a man. Thus, he is mortal".

The conditions of applicability of the deductive **method** should be however carefully scrutinised, because they imply:

- the "**et ceteris paribus**" principle: only really similar issues can be correctly treated in a deductive way

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

- the admission in each case of the validity of the general **determinism** implicit in the applied principles

→ **Abduction; Induction; Inference**

0841

DEFINITION ³⁾

A statement aiming at establishing the precise **meaning** of a term or expression.

The problem of definition is central to **systemic** and **cybernetic semantics**.

In J. WARFIELD's words: "... the definition of a term is in itself an **operation** of **integration**, but what is integrated varies from one approach to another" (1988, p.335).

WARFIELD establishes the following taxonomy of definitions:

"Definition by Naming. In this, the weakest form of definition, a **concept** is given a unique name and that is all that is overtly available to give it an **identity**.

"Second, one may consider Definition by Extension. In this **mode**, well established historically, one deals with a **class** name. The **class** is defined by presenting a **set** of names of exemplars of the **class**. This approach may often serve for initial introduction to a **concept**. It does not provide the depth of insight to allow one to answer such a critical question as to whether a **concept** X, not yet accepted as a member of the **class**, can or should belong to the **class**.

"Thirdly, one may consider Definition by intention. In this **mode**, one deals with a **concept** (which can be a **class**), and defines the **concept** by citing that **set** of attributes that is perceived to be integral to the **concept**. Oddly, this approach may involve both a division and an **integration**. The **integration** brings together a **set** of attributes thought to belong to the **concept**, while at the same time producing a division of the **concept** into the **set** of attributes, leaving open questions of completeness at times.

"A fourth type of definition is Definition by Relationship... but the extent of the **relationship** is a matter of considerable importance... **Definition by Relationship** is the highest grade of the four **modes** discussed" (p. 335-6).

Definition by Relationship implies the use of DE MORGAN's Theory of Relations, whose systemic and cybernetic character is obvious.

The basic **methodology** used in this dictionary is definition by **relationship**, taking in account that any **language** (current, specialized or formalized) tends to be **organizationally closed**.

0842

DEFINITION of a system (Basic)

→ **System (Basic definition of a)**

0843

DEGENERATION ¹⁾

"Process undergone by a system deprived of sufficient free **energy** and thus unable to maintain the integrity of its **rule** system" (Adapted from T.F.H. ALLEN & T.B. STARR, 1982, p.265).

ALLEN and STARR explain: "The system undergoes uncontrolled **change**, which results in a fundamental **change** in system **structure**, characteristic of underconnected systems" (Ibid). (This is because the scant available **energy** is not anymore sufficient to maintain all the **connections**).

0844

DEGREES OF FREEDOM ¹⁾

The measure of the leeway of **variability** in a system.

According to P. BERGE, Y. POMEAU and Ch. VIDAL, a degree of freedom may be understood in two different ways:

- either: "each couple of position-velocity coordinates associated with a possibility of displacement"
- or: "one only of these two elements: position or velocity"

"Thus a set of N bodies able to move in the three directions of **space** presents 3N or 6N degrees of freedom, according to the definition used" (1984, p.13).

The degrees of freedom define the dimensions of the **phase space**.

H. HAKEN and A. WUNDERLIN equate degrees of freedom with "**order parameters**". They state: "Indeed, three **order parameters** or degrees of freedom are enough to make the system **chaotic**" (1990, p.1250).

It is however to be noted that the degree of **correlation** in-between degrees of freedom is a very important factor: less correlated degrees of freedom induce **chaos** much more easily. (see; "**frozen core**") Or, in other terms, **incommensurability** is a determinant factor of **chaos**. The subject seems somehow related to **prime numbers**.

From another viewpoint, R. ROSEN states: "A **functional activity** manifested by any particular system typically involves only a few of the **structural** degrees of freedom of the system" (1974, p.63).

These "free" degrees of freedom are eventually available for other innovative **interactions** or **functional activities** of the system (see "**Function change**").

Degrees of freedom can also be understood in terms of **autonomy** (in P. VENDRYES' sense): Each internal **regulator** with counter-aleatory **reserves** at its disposal, enhances some degree of freedom of the system.

0845

DELAY ^{1) - 2)}

The **time** interval between two successive stages in a **process**.

Some steps in **processes** are more **time-consuming** than others. When **processes** are **interdependent**, the slower ones act as **timers** for the **whole complex system**.

This is, for example, the rationale at the basis of **planning**, and more specifically of **PERT**.

Ignoring differences between delays affecting interconnected **processes** may bring havoc into a system.

→ "**Time lag**".

0846

DELAY AMPLIFICATION ²⁾

The anormal lengthening of a complex **process** due to some small local **perturbation**.

The optimal **development** of a complex **process** is usually represented by a **critical path model**, where it can be observed that such a small local **perturbation** may diffuse in numerous subsequent branches of the **process**, leading to accumulative delay **effects**.

As explained by St. BEER, in such cases it is generally convenient to try to overhaul the whole of the **program** and try to compensate the initial **perturbation** through adequate **action** in order to avoid the development of an unmanageable **situation** (1968, p.192).

As a result, a new **critical path** is to be established.

The subject is obviously related to the **control of chaos** (E. OTT & M. SPANO, 1995).

0847

DELPHI METHOD ^{4) - 5)}

A process of consultation of experts about the future of a system or a relevant **variable** in a system.

This method – a kind of elaborated opinion poll – was introduced in 1963 by DALKEY and HELMER (RAND Corporation, 1963). It aims at establishing a qualitative and quantitative **evaluation** of possible future **changes**, as seen by a number of people (30 to 40) considered as experts at international level in the researched area. Experts remain anonymous.

This is done through written and standardized **inquiry** forms that must be completed according to a strictly defined method. While deviant opinions are admitted, general **convergence** is sought. The **process** is **iterative** and every expert is allowed to modify his/her opinions. After a number of **iterations** – generally four or five – a majority **consensus** is supposed to emerge, with quantitative **evaluations** (for example: there will be 55 % electric cars in 2020).

"The Delphi Method has been used in various **contexts**, in particular where no other procedure for obtaining answers to complex questions is readily available" (J.van GIGCH, 1978, p.432).

The method has been strongly criticized from different angles:

- Which are the **criteria** for selecting the experts?
- Answers are more or less dependent from the way the queries are put.
- **Consensus** is interesting, but gives no guarantee either that the odd man out's opinion is wrong, or that the **consensus** will hit the mark in due time... or ever!
- Conclusions are much more a result of more or less well or ill informed shared subjectivities than truly objective, as they are supposed to be.

M. TUROFF, among others, strongly criticized the method. His view is that it has been mainly used to justify pre-established opinions. DELPHI is obviously weak from an **epistemological** viewpoint. It seems to have been largely abandoned.

Delphi conferencing: A Delphi exercise conducted via computer terminals with "continuous operation and instantaneous compilation and **correlation** of the individual contributions to the group results" (after M. TUROFF as quoted by J.van GIGCH, 1978, p.435).

van GIGCH states: "The **method** of Delphi Conferencing serves to answer the question of designing a **method** that incorporates the advantages of the **Delphi Method** (controlled **feedback** and anonymity) and reduces some of its disadvantages (long **delays** between **iterations** and difficulty in accelerating the **interactions** of participants, without resorting to face-to-face confrontation" (p.435).

0848

DELTA RULE ²⁾

In **parallel processing networks**, "A **learning rule** that utilizes the discrepancy between the desired and actual **output** of each **output** unit to change the **weights** feeding into it" (W. BECHTEL & A. ABRAHAMSON, 1991, p. 306).

"It is also known as the WIDROW-HOFF rule and the least mean squares rule" (p.306).

This amounts to an adaptive **process** based on **feedbacks** and is the basic tool for the progressive betterment of the **efficiency** of the **learning network**.

→ **Learning (Back propagation)**

0849

DEMOSOPHIA ⁴⁾

"The wisdom of the people" (A. CHRISTAKIS, 1996, p.17). Christakis writes: "The name implies a **paradigm** shift from "the power of the people", which is the Greek meaning of the word democracy, to the "wisdom of the peo-

ple". The underlying premise of the new paradigm is that discovering the wisdom of the people is necessary if the people are expected to exercise their power. However, because of the escalating **complexity** of the contemporary societal **situation**, it is much more difficult today to uncover the wisdom of the people than it was two thousand and five hundred years ago during the golden era of the Athenian Republic" (Ibid)

Old Greek experience and present ones (for example in Switzerland the municipal participative debates open to all citizens) show that the "wisdom of the people" can be uncovered mainly (and possibly only) in reduced meetings of at most some few hundred citizens.

Moreover, the present complexity of human affairs at any **level** adds the need for sufficient **information** and evaluating **learning** for all **stakeholders**.

A special interest group of the International Society for the Systems Sciences, as well as the **Fuschl Group** have considered possible ways to revive *demosophia* in new style "agoras" of participative citizens, adapted to nowadays demographic, social and political conditions.

0850

DENDRITIC GROWTH ^{2/4)}

A way of growth through formation of **dissipative structures** along divergent **hexagonal branching fractals**.

A well known example is the **hexagonal growth** characteristic of snowflakes. But dendritic growth appears in many other systems, as for example trees, cities or **clusters** of human settlements (**hexagonal space filling**). It is the result of a very general way of dissipative **structuration** by which the already existing **structures** become definitory of the possibility of **accretion** of new **elements** during the growth **process**.

Dendritic growth **processes** have been mathematically modeled under the name of **diffusion-limited aggregation**.

0851

DENOTATION (Objective) and CONNOTATION ³⁾

According to E.von GLASERSFELD: "... one can show that even the commonest words retain a margin of subjective **meaning** for each individual speaker. Linguists and philosophers of **language** usually subsume this margin under the term "connotation", and they claim to be able to separate the subjective **component** neatly from "objective denotation". From our point of view, this claim rests on the illusion that words refer to things in the real world. In our theory ... words... refer to subjective experiences of the individual **language** user. The separation between denotation and connotation thus no lon-

ger involves **objectivity** but becomes a question of greater or lesser fit with the usage of other speakers.

"The result of our investigations in this area is that the **meanings** of words and longer segments of **language** are never "shared" with others in the sense that they could be considered the same for all members of a **language community**. All one can say is that among proficient speakers of a **language**, **meanings** are at best **compatible**, that is, they function similarly in most **situations**.

"This is an important difference from the artificial, technical **communication systems**. There, the **code** that bestows **significance** on the **signals** is established and distributed to the **communicators** before any **communication** takes place". (E.von GLASERSFELD, 1996, p.493-4)

The telephone repertory of numbers and subscribers could be a good example.

This is also related to the non-**semantic significance** of SHANNON's **Theory of communication**, as specified by SHANNON himself (and generally forgotten).

→ **Objectivity; Ontological Skepticism or Agnosticism**

0852

DENSITY (Critical) ^{1) - 2) - 4)}

The minimal number of individuals under which no collective or social **behavior** can appear, or alternatively the excessive density in a **socio-system** which triggers pathological collective **behavior**.

P.P. GRASSÉ observed that: "... on the occasion of the reconstruction of the nest by termites, there is a critical density of insects under which no **structure** can appear" (1959). He developed this **model** under the name of "**stigmergy**"

J.T. BONNER (1988) and J.A. SHAPIRO (1988) have documented a number of examples. Critical density is also a basic condition for the switch to **swarming** from solitary phase by migratory locusts as shown by UVAROV and FAURE in South Africa and the Belgian biologist H. BREDO in former Belgian Congo and in Central America (see J.P. HARROY: "La lutte anti-acridienne et Hans BREDO" (Académie Royale des Sciences d'Outremer, Bruxelles, 1985)

Critical densities **phenomena** also appear as a basic condition for the shaping and development of human settlements, as demonstrated by P. ALLEN (1982).

What is really critical seems to be the **crowding effect** when the **distance** between individuals is so reduced that a **threshold** is crossed where new **interactive effects** - whether constructive or destructive - become possible (see J. CALHOUN - 1962 and 1971).

Constructive **behavior** appear when numerous individuals coalesce into a system of higher **level**, and destructive **behavior** when **overcrowding** sets in.

The psychological aspect of the **effect** has been considered by E.H. HALL (1966), and the social ones where already more or less perceived by some sociologists since the end of 19th century (S. SIGHELE: The criminal crowd (1892); G.L.E BON: Psychology of the crowds (1895) and J. ORTEGA Y GASSET: The revolt of the masses (1929).

This very important characteristic of loose systems would deserve much more research.

The subject is also doubtless related to **criticality and percolation**, as for example in locusts **swarms** and lemmings collective self-destruction.

→ **Distance (Critical)**

0853

DENSITY OF OCCUPANCY ²⁾

Ideally, **space** tends to be occupied at the same density everywhere (See L.F. RICHARDSON – 1961, p.139).

However, many deforming factors must be considered.

Environmental conditions tend to vary in **space** as well as in **time**.

For example, when a new area is colonized by a **population**, the initial density is quite higher at the "bridgehead" than in the rest of the territory. With **time**, a progressive equalization should take place. However, this would happen only if the **environmental** conditions are more or less equivalent everywhere.

Differential densities of occupation can still be observed in many places in **ecosystems** or in countries like United States or Brazil, because of **environmental** differences both in **space** and **time**.

0854

DENSITY (Optimal) ²⁾

K. BOULDING enounces a principle which he calls "of equal **advantage**" which "...governs the **distribution** of the "substance" of a **structure** among the various **parts** of the **structure**" (1956, p.73).

The **advantage** obtained by a unit or **element** in a defined **location** "is an inverse **function** of the relative quantity of units in that **location** – that is, the fewer, the merrier" (Ibid).

In fact optimal density seems to depend on **two** complementary **parameters**:

1) Any **subsystem** or **structure** needs at least a minimum number of **elements** to become functional.

2) An excessive number of **elements**, i.e. **overcrowding**, produces a slowing down and, in extreme cases, a blocking of the **function**.

Moreover the density conditions vary according to the different stages of **growth** of the system. When **growth** starts, the relation of the system with an **environment** rich in **resources**, induces a considerable **multiplication** of **elements** and an increasing density of the **structure**. With **time** and as the system is nearing its optimal **dimensions**, this **situation** tends to reverse.

Excessive density is a condition favorable to **overburdening**, **overcrowding**, and **overload**. Examples are urban traffic congestion, or epidemics leading to **population collapses**. According to H. ODUM, "**diversity** and a check-and-balance system prevent epidemics and maintain **stability**" (1971, p.80).

0855

DENSITY (Reporting)

→ **Venn diagrams**

0856

DEPENDENCE ²⁾

"The **relation** in which the existence of one **part** is conditioned by some other **part**" (J. FEIBLEMAN & J. FRIEND, 1969, p.34).

"**Independence** is the absence of this condition".

Dependence implies a **hierarchic relation**. FEIBLEMAN and FRIEND give the following example: "...the limb of an animal is dependent upon the circulatory system, but not the circulatory system upon the limb" (Ibid).

They also state that grains of sand (randomly moved by the wind, let us say) are independent of each other. It should be observed however, that, in **composite systems**, like a sand dune, they are at least submitted to a kind of global statistical **order**. As stated by M. BUNGE: "Dependence may be probabilistic, whereas causation is deterministic" (1974, p.235).

F. VESTER emphasizes inner reciprocal dependence (i.e. **sybiosis**) in biological and social systems. He observes that short internal **distances**, reduction of exchanges with the **environment** through increased internal exchanges and lesser use of **energy** diminish dependence from the **environment**. (1983, p.82)

This confirms P. VENDRYES' concept of **autonomy**.

0857

DEPENDENCE AND INDEPENDENCE ^{1) - 2)}

P. VENDRYES writes: "In the 19th century, A. COURNOT (1801-1877) insisted more than anyone else on the fact that **randomness** appears when independent causal series confront each other. This remark leads to a general principle: **Relations** between two **objects** are **random** when they are independent of each other and **deterministic** when they are dependent.

"The fact that the pre-condition of **randomness** is independence, whilst that of **determinism** is dependence, vastly enhances the scientific value of the notions of dependence and independence. And because **autonomy** is an acquired independence it is rigorously logical to assert that physiology makes use of **randomness** in order to be intelligible and therefore is not reliant upon **deterministic** mathematics as its sole system of theoretical reference" (1989, p.146).

0858

DEPICTOR ²⁾

An internal device used by **autokinetic** animals to represent to themselves any variation of their **relations** with their **environment**.

This term was introduced in 1924 by A. LOTKA (p.339-40). LOTKA distinguished four **components** in depicitors: **Receptors**, elaborators, **adjustors** and **effectors**. Their interplay amounts to a global **correlation device**. LOTKA constructed a mechanical walking beetle "exhibiting the several characteristic **elements** of the **correlation** apparatus" (p. 341). The beetle preceded GREY WALTER's *Machina Speculatrix* and A. DUCROCQ's electronic foxes by more than 20 years. It also was an early form of **regulation** through **feedback**.

The term "depictor" never became established.

0859

DEREALIZATION ³⁾⁴⁾

The artificialization of our contact with the real world due to the growing use of **communication** technologies.

C. EMMECHE explains this as follows: "The mass **media** create their own world, an hyper-reality where the gap between **image** and **reality** is erased because everything is mediated, filtered through commentators, news bureaus, **images**, standardized analyses, talk shows, and **events** that are chosen and staged for the occasion. The **media** coverage of an **event** becomes the **event's simulation**, a complicated **game** that for all parties becomes more real than **reality** itself" (1994, p.158-9)

"**Simulation**", with its different psycho-social and computer science shades of **meaning**, is of course becoming one of the master **concepts** of our time. One could however think that in the whole span of existence of human race, our view of the "real" world has always been perceived and simulated - through the filters of myths, **religions**, philosophies or **ideologies**, as instruments to insure the cohesion of **socio-cultural systems**. So-called "derealization" seems in fact to be the contemporary way to generate a new kind of **self-reproducing (autopoietic)** "social cocoon", which appears to have been an ever permanent feature of social and cultural **human systems**.

From the cybernetic and systemic viewpoint, a deeper **epistemological** evaluation of the origins and the scientific and social nature of our **models** would be important. The **emergence** of the **systemic-cybernetic approach** probably signals a decisive mutation for the **understanding** of the collective **behavior** of human masses.

The new situation itself would thus generate the conceptual tools for its own **understanding**.

→ **Deconstruction**

0860

DEREGULATION ⁴⁾

A turn-back from artificially introduced **control-aiming regulations** to natural ones.

A bone of contention is to define what natural **controls** are and which **criteria** are used to distinguish them from artificial ones.

Deregulation, in social or economic systems, does not imply that no **order** whatsoever will remain into the deregulated system, but merely that the "visible hands" are to be replaced by the "invisible hand" (or hands!). Natural **regulations** are largely automatic (as in **ecosystems**, for instance), even if and when tampered with by a *number of different* actors.

In social and economic systems, deregulation easily leads to detrimental consequences for some **stakeholders**. Of course, this also is frequently the case with introduced **regulations**.

0861

DESCRIPTION ³⁾

Description is necessarily done by an **observer**, (or a group of them).

Awareness of "something there out" implies some **change** "here in". In von FOERSTER's words: "Terminal **representations** (descriptions) made by an **organism** are manifest in its movements; consequently the logical **structure** of descriptions arises from the logical **structure** of movements" and this is the case for "the two fundamental aspects of the logical **structure** of descriptions, namely their sense (affirmation or negation) and their **truth value** (true or false)". As a result: "The **information** associated with a description depends on an observer's ability to draw inferences from this description" (1981, p.262-3).

Synthetically, any description is by somebody, in this somebody's terms. von FOERSTER closes the circle, by saying: "The **environment** contains no **information**: the **environment** is as it is" (ibid).

Thus, as stated by A. GOUDSMIT: "...description takes place through the interactive **behavior** itself: it is the **activity** of specifying **distinctions** in the **environment**" (1989, p.172).

Interactive **behavior** supposes that the system (**observer**) is equipped to somehow perceive the **inputs** that will lead to the description. An interesting example are the sunburns by infrared or ultraviolet radiations. When we receive them, we are still unaware of the burns in the making. Since the **effect** is **delayed**, we will be able to describe the sunburns only later on. And, as we cannot directly perceive many electro-magnetic radiations, we are able to describe them only through their *perceived delayed effects*. (two centuries ago, nobody was even aware of their existence).

R. LILIENFELD observed that: "It is possible that "explanation" is a form of **knowledge** that is both secondary and defective and that another, and neglected, form of **knowledge** must precede it. This neglected form ... would be something called description" (1979, p.6).

H.H. PATTEE, on the other hand, states: "Description is not simple". He sees this as a result "... from our inability to reduce the number of **elements** and the number of **rules** that appear essential for the writing and reading of any **structure**" (1977, p.261).

He offers various possible explanations of this inconvenient situation: "First, there is the requirement in formal systems for explicit **representation** of every **change** of the system, whereas in physical systems the laws of motion involving real **space**, **time** and **energy** can take care of many **changes** without needing description...

"Second, the linguistic **rules** of formal descriptions can produce only **discrete** serial **operations** rather than **parallel continuous operations**. Construction, on the other hand, can often be performed most efficiently with **parallel** and coordinated **dynamics**.

"Third, interest in formal **programs** and **machines** usually depend on mathematicians' predisposition for generality or universality which greatly complicates their expressions" (ibid).

PATTEE went even farther and observed: "... the more you describe the measuring device, the less effectively it measures or describes the system" (ibid., p.262).

He also stated: "...what we measure is determined by what we choose to ignore about the dynamical details of a system" (1972, p.36). This is quite coincident with HEISENBERG's **indeterminacy relation**.

We are thus not only restricted in our **perception** of reality by sensorial limitations, but altogether in our description of it by our **modeling languages**, formal or just common. In L. LÖFGREN's words: "To notice that a describing system is influencing its descriptions does indeed suggest the idea that what can be objectively describe is limited" (1978, p.244).

This is in some way a startling generalization of HEISENBERG's **indeterminacy**! It also implies a significant limitation to the power of the **observer**.

PATTEE's conclusion: "However, until the essential **epistemological relation** between descriptions and **dynamics** is faced as a fundamental problem, I doubt if we can claim a useful theory of **complex system behavior**" (ibid., p.265).

0862

DESCRIPTION (External System's) ^{2) - 3)}

R. ROSEN distinguishes two kinds of system descriptions: external and internal (see hereafter).

According to him, the external description is the "**black-box**" description. He states: "In this **situation** we make no attempt to identify a set of **variables** for the system. Rather we have at our disposal a family of **perturbations** which we can apply to the system, variously called forcings, or **inputs**, and one or more observables which we use to index the **effect** of applying a particular forcing or **input** to the system. Such system observables are generally called system **outputs** or **responses**" (1972, p.51).

This kind of description allows for a better **understanding** of the relevant **environment** of the system and its impacts on the same, but does not easily enlightens the **autopoietic** characteristics of the same.

0863

DESCRIPTION (Internal System's) ^{2) - 3)}

This is the traditional way of description.

R. ROSEN states: "Typically such a description begins with a characterization of what the system is like at an instant of **time**; such a characterization is said to define a *state* of the system. The totality of all the possible **states** of the system, meaning the totality of different aspects the system can assume for us at an instant of **time**, forms a set called the *state space* of the system" (1972, p.50).(with the corresponding **state variables**).

This is satisfactory for **linear** systems, but quite insufficient for **nonlinear** ones. In these cases, at least two essential characteristics of the system escape to this kind of internal description:

- the mechanism of **self-catalytic hypercycles**, which describes how some **states** are regenerated from other **states**;
- The **organizational closure**, closely related to the former **mechanism**, which determines which **states** are admitted and which ones are excluded, in order to maintain the system's **identity**.

0864

DESCRIPTION (Self-) ²⁾ - ³⁾

H. PATTEE states: "The fundamental fact of life – a fact of such universality that it may be used to define life – is that *living systems contain their own description*" (1977, p.259).

This fact is closely related to **autopoiesis**, which would be impossible without the existence of a **specific template**, containing the basic traits of any individualized entity. Self-description also would be a condition for self-reproductive artificial **automata**.

Nevertheless, L. LÖFGREN observes: "It is important to clarify PATTEE's statement that *"complete self-description of any system is a physical impossibility, though not a logical of formal impossibility"*. LÖFGREN observes: "If complete self-description is meant to describe all of the description **process** itself (including both description and interpretation), then it is *logically impossible*. This has been shown by TARSKI, and somewhat later by GÖDEL" (1979, p.247).

The incompleteness of self-description explains why no system is ever able to reproduce itself *forever*. It is **autonomous** and **organizationally** closed, but never **independent** of basic conditions that transcend it.

0865

DESCRIPTION THROUGH HIERARCHICAL LEVELS ³⁾

H. PATTEE states: "The scientific description of **events** would, in fact, get nowhere in nature's maze of **complexity** unless there were repeated resimplifications which we call hierarchical levels of description" (1972, p.37).

He adds: "In fact every **process of classification** implies the grouping under a single **class** of **objects** which, according to a more detailed **classification**, fell in more than one **class**" (ibid).

While "description" is a mental artifact, it need not be arbitrary, since it is related to **levels of action**. We describe, for example social **interrelations** between plants, animals or men, putting into mental brackets the physiological, biochemical or physical **levels of action**, but this does not mean that we ignore their existence and fundamental importance. Moreover, we more or less clearly perceive **organizational analogies** between these **levels**. An outstanding example are the **crosslevel hypotheses** of J. MILLER in his "**Living Systems**".

0866

DESCRIPTIONS (State and Process) ³⁾

H. SIMON makes the following point: "A circle is the locus of all points equidistant from a given point... To construct a circle, rotate a compass with one arm fixed until the other arm has returned to it starting point. It is implicit in EUCLID that if you carry out the **process** specified

in the second sentence, you will produce an **object** that satisfies the definition of the first. The first description is a state description of the circle, the second one a process description" (1965, p.73).

While this is well known, it is quite frequently forgotten in practical management of **complex systems**: Many costly errors result from **actions** on a **dynamic system** made on base of a static state description.

0867

DESIGN ¹⁾

1. "A procedure aimed at the solution of certain non-trivial practical problems, or..."

"... a methodological **phenomenon** of the practical sciences" (W. GASPARSKI, 1993, p.407).

GASPARSKI gives us a systemic **evaluation** of the more classical **methodology** of design. Commenting his two definitions, he writes: "The former... may be defined as the **methodology** sensu stricto, whereas in the latter, the **methodology** of design is tantamount to the **methodology** of the applied (practical) sciences. There are also definitions which treat jointly both **concepts**, as one whole; these may be called the **methodology** of design sensu largo" (ibid).

About design as a technique for "constructing things", T. KOTARBINSKI, as quoted by GASPARSKI, wrote: "Saying of someone that he is constructing a design of a certain thing, we usually mean that, having decided to accomplish a certain task or to advise its completion, he endeavours to contrive the conditions necessary for carrying into effect that task, i.e. work or product... Any engineering specialization (science of bridge construction, machine construction, etc.) may be called a practical science, since it is primarily concerned with designing" (p.408).

Classical design starts with the definition of the **problem** to be resolved, through the analysis of the existing system. It defines the scope of a project to modify it and it studies the feasibility of the same. The design phase by an expert or a board of experts consists in the authoritative description of the proposed new system and of the steps to implement it. Consultations rarely cross the limits of (limited) technical **assessment** and mostly disregard other and more general aspects. It is very seldom socially participative.

In fact, such a formulation, while not objectionable per se, forgets the human aims of design: We **want** to construct "things" because we pursue personal and social **goals**. Thus design is not merely a technical endeavor.

As observed by E. STOLTERMAN: "It is not only **knowledge** about *how to design* that is needed. I think that to be a good designer it is of utmost importance to have **knowledge** about design. It is important to reveal hidden

preconceptions and **assumptions** about design practice. This has to be done by questioning the traditions and **values** predominant in the specific design area. Design **learning** should not be a **process** of conservation where existing practice is taken for granted and the only answer. Design **learning** is not a question of a simple transfer of established **knowledge** from experienced designers to inexperienced designers" (1992, p.1028).

It is now moreover becoming obvious that design should include a previous critique of these aims from various angles as for example possible **long term** results and ecological soundness (see B. BANATHY's definition and comments).

GASPARSKI thus quotes S.A. GREGORY, who makes the point: "The science of design should develop all **interdisciplinary** potential and employ not only the achievement of disciplines concerned with detailed design, but also of managerial science, **systems engineering**, and those aspects of behavioral sciences which deal with designing, designers, design institutions and social implications of design" (p.413).

Unfortunately, such aspects of behavioral sciences are still somewhat embryonary, in spite of ACKOFF, BANATHY, CHECKLAND, CHURCHMAN, van GIGCH's and others efforts.

2. "A creative, **decision-oriented**, disciplined enquiry" (B. BANATHY, 1988, p.27).

B. BANATHY gives the following explanations about his systemic **concept** of design: "(it) first clarifies the reason for engaging in design, and then diagnoses and describes the design problem **situation**; formulates expectations, **purposes**, and requirements of the system to be designed or redesigned; generates and clarifies alternative **representations** of the system that can meet those requirements and expectations; devises **criteria** by which to evaluate those alternatives; describes the most promising alternative and prepares a plan for the development and implementation of the selected design" (ibid).

And still: "Design will take on the characteristics of **learning**" (ibid., p.30).

Some supplementary pre-requisites seem necessary:

1) One great danger at the beginning of the design **process** is the "ignorance of ignorance" (J. FOURASTIÉ), or the "**invisibility**" problem (G.DE ZEEUW), or "**underconceptualization**" (J. WARFIELD). When we ignore some basic aspects of the **situation**, we may very well formulate, or worse, tacitly believe in incomplete or even false **assumptions**. In this case, all our design will rest on shaky foundations. We have thus a very important preliminary difficulty to solve: How do we get "out of our system". This could be called the "perceptive problem".

2) We should not ignore, or at least should try to become conscious of our own socially and culturally conditioned **mindscapes** (M. MAR-

UYAMA), which may in many cases, distort our **perceptions** and **understanding**. This could be called the "ideological distortion".

BANATHY is obviously aware of these problems as he emphasizes the need for: "front-end analysis/diagnosis of the design problem **situation**: **clarify** organizational culture and reason for design, formulate organizing perspectives that guide the design, explore barriers that prevent/hinder our continuing development, develop a rich picture of the design problem **situation** and, display a systemic analysis and structured **description** of the design problem **situation**" (p.33).

Still, how do we take distance from ourselves, as "**autopoietic** thinkers" (or tinkers!)?

For a quite complete overview of the systemic concept of design as seen by all significant authors in the field, the paper on "the practice and ethics of design" by K. BAUSCH should be consulted (2000, p. 23-50)

0868

DESIGN CONVERSATION^{1) - 4)}

A **methodology** of design to be applied to specific issues or tasks in organizational and social settings.

B. BANATHY, who advocates the methodology, sees it as a combination of **generative dialogue**, used to reach a common **frame** of thinking, and **strategic dialogue** in which specific issues are considered. (1996, p.39).

For practical uses, both types of **dialogue** are complementary and necessary.

0869

DESIGN (Co-participative)^{1) - 4)}

A design **process** in which each and every **stakeholder** takes part.

The classical design **process** of some specific project by experts – generally without due consideration for the **context** – leads evermore frequently to great disasters (C. FRANÇOIS, 1989, p.1101-11).

This is a result of single mindedness of the over specialized experts or pressure **groups**.

The only way to acquire a good **understanding** of the multiple aspects of any **situation** is to consult and listen to **all** those who are enmeshed in it and, when possible after giving them the suitable **information**, discuss the critical points with them in order to reach consensual conclusions and **decisions**.

Such a **process** could be long and painful, but it is the price to be paid in order to avoid still more painful and, in many cases irreversible negative results. Moreover, with time, better co-participative design **methods** will hopefully be developed.

0870

DESIGN CULTURE (System-oriented): The CHIOS DECLARATION¹⁾²⁾⁴⁾

A. COLLEN and W. GASPARSKI (1995, p.453-55) reproduce the following **concepts** formulated in this declaration by the participants of a Workshop on Developing a Design Culture in Higher Education that took place on the Island of Chios in Greece (1988).

The Declaration appeals for "a system-oriented design culture as an alternative culture to cope with the **complexity** of contemporary world"

"The culture is defined by the following four **goals**:

"1. To develop articulated design philosophy that can be accepted to guide intellectual leadership to creating the culture.

"2. To develop a suitable **language** for communicating design **concepts**.

"3. To create a better balance between **analysis** and **synthesis** in **education** and practice.

"4. To create a less restrictive but still definite view of what constitutes acceptable scientific **knowledge**".

The following suggestions were made to enhance the quality of design in systemic terms:

" - Open discussions on design culture with the participation of non-design culture oriented people (from academia, specific design professions, and laymen) should be organized.

" - Widely defined **multidisciplinary** research **groups** should be introduced.

" - A common **understanding** of the **concept** of "design" and its connection with **systems theory**, **planning**, **strategic management**, and other relevant **theories** should be developed.

" - The presently existing conceptual scheme of **systems thinking** and a system based **design theory** with general acceptability to the relevant view of **human action** should be completed.

" - The design theory should be positioned within the wider outlook of **systems sciences** and curricula that teach it as a core subject at the M.S. and Ph.D. levels, should be developed.

" - **Social system models** of an operating design culture in higher **education** should be developed.

" - A devoted **multidisciplinary group** of people to play the leading role in the spread of design culture should be developed,

" - The maximum possible **resources** to these areas of science that will offer the means to the society to take full and quick advantage of a new integrated **language** culture should be allocated".

By way of conclusion, W. GASPARSKI quotes H. SIMON, who wrote in "The Science of Design": "The real subject of the new intellectual free trade among the many cultures are our own thought **processes**. We are importing and exporting from one intellectual discipline to another ideas about how a serially organized in-

formation-processing system like a human being – or a **computer**, or a complex of men and women and computers in organized **cooperation** – solves problems and achieves **goals** in outer **environments** of great **complexity**

"...we can conclude that, in a large part, the proper study of mankind is the science of design, not only as the professional **component** of a technical education, but as a core discipline for every liberally educated person" (1981, p. 159)

0871

DESIGN (Generic)^{1) - 2)}

"That part of the **process** of design that is indifferent to what is being designed, being applicable whatever the target may be" (J. WARFIELD, pers. comm.).

To generic design, WARFIELD opposes specific design, "that part of the **process** of design that is particular to the target class" (ibid).

Targets can be for example a product, or a system that, in turn, can be "tangible or intangible".

WARFIELD enounces 32 basic postulates of Generic Design, related to:

- "The human being (7)
- "**Language** (6)
- "Reasoning through **relationships** (2)
- "Archival **representation** (6)
- "The design **situation** (2)
- "The design **process** (9)

WARFIELD's Generic Design methodology has been applied in a number of countries in Europe, Asia and both Americas. For a complete exposition of the **methodology** see bibliography (in particular: 1990, d).

0872

DESIGN (Heterarchical)^{2) - 4)}

A **model of organization** in which each participating **element** is more or less multivalent and, to a point, able to fulfill various **roles** in a **co-participative** way.

This **model** has been mainly developed by J. A. JOHANNESSEN and his co-workers (1991, 1992, 1993).

0873

DESIGN INQUIRY²⁾

A research centered "on the possibilities for **structural**, **functional** and transformational **changes** in **Human Activity Systems**" (A. COLLEN, 1992, p.563).

COLLEN comments: "The long standing preoccupation in institutions, corporations and governments with strategic **planning** does not serve well the **long term processes** of societies and the planet... and the growing **interde-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

pendence among nations and transnational corporations confronts those in the most industrialized societies in particular with a startling challenge to an established way of life" (Ibid).

The most important need is a satisfactory **understanding** of the complex present **interrelations** of the system to be modified, with its **zone of activity** in its **environment**. In particular, much care should be taken about the "**invisibility**" of some aspects of the **situation** under consideration.

Designers should also research carefully the possible unforeseen consequences of the **changes** they wish to introduce into the system, in view that the positive sum **game** is quite generally a fallacy: desired **changes** are to be paid for, somehow, sometime, by somebody or by the **environment** (with probable **feedback**, according to the "no free lunch" principle), and it is better to know the price, or at least to try to know it before taking any irreversible **decision**. This is best done when every **stakeholder** is duly consulted.

0874

DESIGN: Its program ¹⁾²⁾

W. GASPARSKI et al. select the following aims and **contents** for design, as enunciated by a number of authors from 1936 to 1972 (for details see 1995, p.17-18):

"**Diagnosis** of practical **situations**, investigation of principles and **methods** of design realization" (KRECZKOWSKI, 1936)

"**Knowledge** concerning physical and economic **interdependences** and psychological conditioning of technical production (F. KESSELRING, 1954).

"**Normative knowledge** of principles and **procedures** of design and **methods** of **evaluation** of design solutions" (K.L. GREJNER, 1963).

"Studies, research, and accumulation of **knowledge** on the design **process** and its component **operations** as well as social conditioning" (S.A. GREGORY, 1966).

"Science related to the problems of "artificiality" of man-made products as opposed to natural products. It comprises: theory of the **evaluation** of the design results, logic of **synthesis**, theory of **structure**, formulation of design problems, and design **organization**" (H. SIMON, 1969).

"Theory based on mathematical **methods**, particularly on **decision theory**" (M. TRIBUS, 1969)

"General theory of design practice, aiming at development of "design **consciousness**" involved in the **process** of social **changes**" (T. MALDONADO, 1972)

"Philosophy and logic of design based on the adapted program of **methodology** of sciences by ADJUKIEWICZ. It differentiates between the theory of the **object** of design (apragmatic **methodology**) and the theory of the design

process (pragmatic **methodology**). Object of design and design **process** are considered as ideal types. General and detailed **methodology** are differentiated" (W. GASPARSKI, 1972).

Bela H. BANATHY and J. WARFIELD - among others - have also signaled other important aims and **methods** (See other entries on "design")

0875

DESIGN METHODOLOGY (Systemic) ^{2) - 4)}

B. BANATHY proposes the following design methodology, in correspondance with his general systemic **understanding** of what design should be in order to be creative and adaptive, as well as better tailored to human needs (1988, p.32):

"The system creation is carried out in the design solution space, which is surrounded by the design genesis space, the design **experimentation space**, the space in which we organize **knowledge** that informs our design, and the space of the future system.

"In the contextual/design genesis space, the stage is set for design. In this space we reason for design, formulate organizing perspectives that shall guide design thinking and **action**, and develop a rich picture of the design problem **situation**".

Of course, in this statement, the most important word is "we". The identity of the designers, their stated or unstated **goals**, their prejudices, their mental **frames of reference** are of utmost importance. Here, systemic design parts company with classical design, which (in societal "engineering") is generally authoritarian and speciality bound.

BANATHY proceeds: "In the organized **knowledge space**, **information** and **knowledge**, pertinent to design inquiry, are continuously infused and organized to inform design in a timely fashion and provide substance to the generation of alternatives.

"The experimentation space is created in order to allow for design experimentation and the testing of emerging design alternatives as well as the **assessment** of the on-going design itself.

"The space of the future system will contain the **model** of the system to be designed as well as the **model** of the systemic **environment** of the future system.

"It is the **design solution space** in which we formulate the **image** of the future system. In this space, **design inquiry** is carried out in a spiralic manner as we explore and re-explore the various spaces of design inquiry... and integrate **information**, **knowledge** and experience into the emerging **image** of the future system" (Ibid).

Thereafter, BANATHY enumerates the successive stages of the **design inquiry**:

"Stage one: front-end analysis/ diagnosis of the design problem **situation**: clarify organizational culture and reason for design..., formulate organizing perspectives that guide the design, explore barriers that prevent/hinder our continuing development..., develop a rich picture of the design problem **situation** ..., display a systemic analysis and structured **description** of the design problem **situation**.

"Stage two: the design of the ideal system: formulate expectations, **purposes**, and aspirations of the future system..., formulate a root-definition of the system..., select type of system we want to become (e.g. **purpose-seeking**)..., formulate desired system characteristics..., explore and evaluate alternative **configurations** of **functions** by which to attain stated **purposes**..., select and test and describe the ideal system.

"Stage three: the design of the enabling system: the design of the **management system** and the organizational design that enable us to move toward the realization of the ideal future state.

"Stage four: the implementation **planning** stage: **planning** the **means** and **methods**... and the **strategies** ... by which we can implement the feasible and attainable **representation** of the ideal design and develop the enabling systems, and design the change delivery system."

There is of course a general caveat: BANATHY's approach is ethical and idealistic. It could however be distorted by ideological biases (conscious or unconscious), as well as by specific pressure **groups** interests.. This in turn offers curious implications: if all the participants in the design **process** share the same prejudices - even (in our own view) harmful ones - they would be in their right to proceed, as long as they do not provoke problems outside their own **domain**, ...or are supposed not to.

Design "a la BANATHY" should always be as much **co-participative** as possible, precisely to obtain a maximum opening of the spaces and **stages** he describes, and a genuine (and adaptive) **consensus**.

0876

DESIGN or PLANNING? ²⁾

E. JANTSCH proposed the two following basic **rules** "for purposeful **organization** or **planning**":

"1. Make **structure** as flexible as possible, so that it can be changed by emergent **changes** in the **interaction** of **processes**; and
"2. identify and enhance evolutionary **processes** of **change**, recognize and respect their self-bounding nature" (1975, p.63).

These **rules** (themselves part of a good **understanding** of the nature of systems) seem also absolutely needed for defining clearly "the vision of what should be" in systems design as proposed by B. BANATHY, if biases of any kind are to be avoided.

If so, **planning** will probably converge into design in a not too faraway future.

0877

DESIGN (Systemic approach to)²⁾

B. BANATHY writes: "In sharp contrast (with the traditional social **planning**) the systems design approach seeks to understand a problem **situation** as a system of interconnected, interdependant and interacting **problems**, and creates a design solution as a system of interconnected, interdependent and internally consistent solution ideas. Design is a journey by which we can bring about a desired future **state** of our system" (1992, p.550).

According to BANATHY the design **process** goes through four successive stages:

1) Formulate the core definitions about the nature of the system and the vision of the **stakeholders**.

2) Develop the specifications, as for example services to be offered by the system, in which way and to whom, ownership, **rights and responsibilities**, etc...

3) Design the system of key and **subfunctions**, to be arranged in a coherent way.

4) Design the **organization** on the base of the **functions** to be fulfilled and the practical possibilities to fulfill them.

BANATHY refers himself to systems design as to a "journey", emphasizing its dynamic character. It should be added that the design **process** of a system never ends as circumstances are permanently changing. Moreover, the results of **action** are to be repeatedly monitored and fed back to the **process**, in order to introduce possible corrections.

0878

DESIGN (Systems)^{1) - 2)}

"The full scope of **activities** by which we attempt to construct systems that are adequate **models** of desirable man-made **objects**" (G. KLIR, 1993, p.30).

This implies that the "desirable artificial **object** can be constructed in such a way that relevant objective **criteria** are satisfied within given **constraints**" (ibid).

The definitions of what is desirable and what are objective **criteria** are of course difficult to establish. Also, "**objects**" can be abstract: research projects, institutions, **social systems modes** of **organization**, etc.

This point is made by B. BANATHY: "Systems design in the **context** of social systems is a future creating disciplined **enquiry**. People engage in design in order to devise a **model** of a

system, based on their vision of *what should be*. They seek to create a design that has a "goodness or **fit**" with their larger society and with their own expectations..."

"This approach is very different from the widely practiced traditional social planning, which reduces the problem to manageable pieces and seek solutions to each" (1992, p.548).

In accordance with BANATHY, ACKOFF writes: "To design a system is to develop a **representation** of a system that does not (*yet*) exist" (1988, p.245).

Some important points should be noted:

- the design escapes from the dangers of ideological bias, if *people*, i.e. each and everyone of the "**stakeholders**" in the project effectively and personally participates in the **design process**.
- and if the whole area of possible **situations** is duly explored by the **community** of participants.
- experts are to be consulted when needed, but are not to be placed in the position of all powerful **deciders**.

0879

DESIGN: The BOSTON MANIFESTO¹⁾²⁾

Prof. G. NADLER produced this Manifesto at a Congress in Boston in 1988. The following excerpts are quoted from A. COLLEN and W. GASPERSKI (Eds.) book on "Design and Systems" (1995, p.452-3)

"**Planning** and designing have the purpose of creating or restructuring a system or a solution for specific **situations**. Successful **planning** and **designing** produces effective and possibly innovative recommendations for systems (products, buildings, **information flow**, **organization**, etc.) that are implementable. P&D is defined as the **process** or **approach** mode to connote the continuing need and nature of creation or restructuring systems in our world. Plans and **design** describe the results (recommendations and solutions) of the P&D **process**".

...The Manifesto proposes the following agenda:

- To encourage scholarly and practitioner discourse (set up a **network**)
- To institute **procedures** for the further **interdisciplinary** development of a systematic body of **knowledge** about **planning** and **design**
- To set up international standards for research in P & D **theory** and **methodology**
- To assist in the dissemination of new **knowledge**, through publications, workshops, conferences and other such media
- To promote the study of actual **planning** and **design** practices, and to analyse their respective strengths and weaknesses, and to evaluate their **effectiveness**

" - To support the development of **methods** and **tools** for the enhancement of **planning** and **design**

" - To encourage the professional schools to emphasize **design theories** and **methods** in their curricula

" - To serve as a **coordination** group for and a **stimulus** to P & D groups in each of the P&D professional areas (e.g. engineering, architecture)

" - To foster public **awareness** of the significance and importance of the activities of **planning** and **design** and their various approaches

" - To work on the development of a P & D Honor Society" (p.453)

Most of these recommendations are basically instrumental in a practical sense.

For more elaborated concepts on "a system-oriented design culture", see hereafter.

0880

DESIGNATA¹⁾³⁾

The objects symbolized by the **signs** used to represent them.

This relation between the **objects** and their designata is the main concern of **semantics**.

0881

DESTABILIZATION (Signals of impending societal)^{1) - 4)}

K.E.F. WATT and Paul F. CRAIG suggest seven kinds of signals of impending societal destabilization:

1. Dangerous **dependence** on a single critical limiting **resource** at risk of near-term supply curtailment
2. A dangerously coarse-grained **environment**
3. Lack of **redundancy** in the social infrastructure. (What do we have already in place to allow us to survive sudden curtailment of petroleum supplies?)
4. Lack of fast-acting **negative feedback loops** in **complex systems** of impending **resource** shortages, sets systems up for shocks
5. Top-heavy, multi-layered, rigid **organizational structures**
6. Curtailment of migration because of prohibitive **resource costs**
7. Excessive **connectance** between the economics of different nations means that now, a shock anywhere translates into a shock at other, remote sites" (1986, p. 200).

Some of these **signals** at least are valid for enterprises, individuals and, in ecological settings, for species.

0882

DESTRUCTION

→ **Self-destruction of systems**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0883

DESTRUCTURATION ¹⁾ - 4)

The loss of internal **order** in a system.

This is sometimes an *intermediate phase* in the existence of the system, preceeding a fundamental reorganization or a jump toward a higher **level of organization**. Its seems that the **elements** need at some moment be freed from their former **links** in order to re-arrange themselves into a new **structure**.

The cause and reasons of this **phenomenon** have not yet been seriously explored.

A good example is moulting in insects. Another could (hypothetically) be revolutions in human societies.

Still another example is J. SCHUMPETER's "**Creative destruction**" (1954, p.161). According to this Austrian economist, every important economic evolution generated by technical **progress** starts inevitably with the **destruction** of a number of old **structures** - trades, businesses, **rules** - not anymore adapted to the new conditions. This leads to a restructuration, generally much more varied and complex, with new trades, new products and wider and more inclusive **rules**, which allow for further economic **progress**.

E. KAHLER (1968) describes the same **process** in the 20th. Century arts, at least in terms of general desintegration of **form**. Remains to be seen if a restructuration will take place in the future.

0884

DETECTION (Delayed) ²⁾³⁾⁴⁾

In many systems submitted to study by **observers**, some **effects** are not, or only very lately, registered.

The causes may be of different orders:

- the effects are small and only accumulate in the long **term**, thus escaping the gaze of the circumstantial or casual observer
- the effects are of a new type and the observer lacks the mental **reference frame** for their **understanding**, or even their **perception**
- the effects are still potential, as possible consequences of other **events** ignored, misunderstood or considered irrelevant by the observer. This is particularly true for new technologies or faraway **events**.

These various factors produce some common results. The observer is taken by surprise and frequently quite unprepared to react efficiently. Such a situation may be very damaging for the observer and/or for the system itself.

However, as noted by K. MATSUNO, when various effects of different nature are acting simultaneously in a system and, in cases, out of the **phase**, a global possibility for **adaptation**, or even **evolution**, becomes stimulated (1998). In such a situation, early detection is even more important.

→ **Time horizon; Time lag**

0885

DETECTOR ¹⁾ - 2) - 4)

Any device usable to discover and measure some characteristic of an **environment** or a system.

In biological systems, the famous "**Frogs Eye**" experiment by J.Y. LETTVIN et al. "... showed how the built-in classes of visual detectors in the frog's retina correspond to perceptual **categories**" (J.L. SNELL, 1988, p.360).

This also shows that biological detectors have an ingrained evolutive history and are not only detectors but moreover **selectors** and **transducers** whose transparency is far from total. (See LOTKA's concept of **descriptor**). It would be interesting to define and study the nature of social detectors. **Values, norms, ideologies**, etc... are probably such social selective detectors.

0886

DETERIORATION ¹⁾

A **process** of progressive **decay** that affects the **structures** of any system through **time**.

Deterioration is an unavoidable consequence of the **2nd law of thermodynamics**. It can be avoided during a more or less long span of **time** if the system disposes of self-**maintenance** devices, for which of course a price in **energy** use must also be paid.

This notion is very important, because it constitutes the perceptible **nexus** between **time** and **energy**.

0887

DETERMINATION ²⁾

The way the present **state** of a system has been reached as a result of the sequence of its former **states**.

W. KARGL writes: "The global past of an individual system does not condition in an absolute way its future, but only the **distribution** of its possible future **states**" (1991).

0888

DETERMINATION (Multiple) ²⁾ - 3)

The **effect** on **behavior** of a number of **simultaneously** convergent **causes**.

G. BATESON gives a striking, everyday life example: "We turn off the light when we go to bed, influenced partly by the economics of scarcity, partly by premises of transference, partly by ideas of privacy, partly to reduce sensorial **input**, etc..." (1973, p.476).

Unfortunately, our belief in **linear causal determinism**, acquired through traditional training, many times blinds us to multiple determination and leads us to gross and at times, dangerous simplifications.

0889

DETERMINISM ¹⁾ - 3)

"The belief that the future **state** of a system is completely determined by its present **state**, the same **causes** producing the same **effects**" (E. SCHWARZ, 1993, p.4).

This at least, is a definition specifically formulated in relation to systems.

SCHWARZ states, rightly it seems, that determinism is a belief, resulting of an **epistemological** attitude.

Determinism is one of the most abstract and ill-interpreted concepts in the history of science and philosophy. As noted by G. ISRAEL, numerous definitions have been given and the concept appears on different conceptual **levels** (1992, p.252).

Misunderstandings about determinism lead easily to misinterpretations about **complex systems behavior**. While necessarily very sketchy and inconclusive, a discussion of the subject is unavoidable.

To begin with, determinism cannot be reduced to a **principle of absolute causality**, that has been "...the dominant metaphysics of modern science" (p.253).

The word appears in Germany during the 18th Century (LEIBNIZ), but is imposed by Cl. BERNARD in France, around 1860: "There is an absolute determinism in all sciences", or "It should be admitted as an experimental axiom that in living beings as well as in raw substances, the conditions for the existence of any **phenomenon** are determined in an absolute manner" (1952, p.111). He however repented somewhat later on: "When I introduced for the first time the word *determinism*... I was not thinking that it could be confused with LEIBNIZ philosophical determinism" (1878, p.55)... However, it was!

G. ISRAEL concludes: "Last century's scientific determinism is an **epistemologic doctrine** deriving from Cl. BERNARD's thesis" (p.257). As a result, determinism seemed to have an absolute **ontologic** value.

No significant problem emerged from this viewpoint as long as science was directed to the study of **linear** or reducible to **linear processes**. The difficulties started on one hand with BOLTZMANN's statistical **thermodynamics**, and on the other with POINCARÉ's **3 bodies problem**, which was a harbinger of **chaotic behavior** of systems with **sensibility to initial conditions**.

Thus seemingly **random transformations** in the systems **behavior** started to mix a statistical aspect with a kind of diffuse surviving determinism. As with quanta, relativity and Prigoginian **thermodynamics**, clearcut, absolutist concepts of the past have to give way to more intricate and subtle **models**. "Cause" becomes now a complex **web of causes** and determinism becomes at the same time diffuse and generalized in **space** and **time**. It must fi-

nally be admitted that science only constructs general **models**, while any concrete **phenomenon** is a particular case, because it is a specific result of a unique, but complex **history**.

0890

DETERMINISM (Chaotic)→ **CHAOS (Deterministic)**

0891

DETERMINISM (Concept of absolute)³⁾

"The theory that the **behavior or processes** of systems can be precisely and fully forecasted" (Adapted from J.Z. YOUNG, 1978, p.291).

YOUNG claims that the concept must be "considered to be meaningless because no such principle can be demonstrated".

The concept of absolute determinism was enunciated as follows by LAPLACE: "An intellect which at a given instant knew all the forces acting in nature, and the position of all things of which the world consists – supposing that said intellect were vast enough to subject these **data** to analysis – would embrace in the same formula the motions of the greatest bodies in the universe and those of the slightest atoms; nothing would be uncertain for it, and the future, like the past, would be present to its eyes".

Nobody can object such a statement, about a "theory of everything". But, obviously, no human being, nor any other living being possesses this Laplacean "intellect", as shown by relativity theory as well as by HEISENBERG's **indetermination** principle.

While LAPLACE's statement was unequivocally hypothetical and quite carefully worded, subsequent 19th century generations of scientists and philosophers adhered to the concept as if it were possible, true and necessary as a rigorous **causal** (and even sometimes mon-causal) principle that should be applied strictly to every kind of scientific work.

Indeed, various aspects of such an absolute principle and its applications came under close critical scrutiny during the 20th century:

1. Physicists have been compelled to admit a basic **indeterminacy** at micro-physical level. No "human intellect" can know "all the forces" and "the position of all things" at a given moment. This **situation** turns elusive the quest for causal determinism and future becomes **fuzzy** and not anymore rigorously **predictable**. **Observation** perturbs and non-**observation** leaves us in the dark.

2. It is not anymore evident that the Universe is globally and perfectly coherent. As **simultaneous** local causes cannot propagate instantaneously, global determinism, if it exists, breaks up locally everywhere: local and more or less provisionally disconnected determinisms appear and provide for a more or less **chaotic** and **unpredictable** future.

3. Any **universe** (or system) is at least partly blind to itself (see Jumarie's **relativistic theory of information** – 1980 and 1982). The only perfect **model** of the **universe** (or the system) is itself. This could lead to a very curious reformulation of LAPLACE's statement.

4. Our laws (deterministic or otherwise) are **constructs**, or **algorithms**. We acquire them by **consensus**, but they are never completely immune to **falsehood** "à la POPPER". We do read some measure of determinism in the universe, but we are safer **epistemologically** than **ontologically**.

As to systems, a **consensus** seems to be emerging: any system is governed by some basic determinisms at global or macro level, but its **organizational closure** provides it with a more or less broad measure of **autonomy**, i.e. the (determined!) capacity to determine itself, within **limits**.

It has ultimately become clear – through the theory and **models** of **deterministic chaos** – that determinism is necessarily **relative** due to the successive disconnections and reconnections of **simultaneous events in complex systems**. This introduces a relation of traditional determinism with the **reversibility** concept.

According to F. BONSACK: "When we look for an example of determinism, we readily recall two **phenomena**: the first, the collision of perfectly elastic balls, the other one, the rotation of the planets around the sun. One may make a remark that, at first sight, could look as anecdotal: both cases are related to **almost reversible phenomena**. Laplacean determinism is **reversible**: starting from time t_0 , one may compute the **state** of the system at a future time t_1 as well as at a former time t_{-1} . Moreover, in the balls **model**, one reaches a paradoxical **situation**: it is possible to go back earlier than the initial **situation**" (1983, p. 113).

The apparent paradox is a result of the ever recurrent confusion between the real **situation** and the **model** we use to describe it. **Reversibility** exists only within the conceptual **model**. The planet JUPITER has occupied, occupies and shall occupy (very probably) a certain position (related to an **abstract frame of reference**) on various moments of the past, the present (unique) and the future. But it cannot really backtrack in the **time dimension**. The various past and future positions are merely **computable**.

The real interest of classical determinism is of a practical nature: it permits to retrieve former **situations** and to predict future ones by computation, always within the **limits** – sometimes dubious – of the "...**et ceteris paribus**" principle.

F. BONSACK immediately makes the point:

"Laplacean determinism is **reversible**. But our familiar notion of **causality** is not: the **cause** is always clearly different from the **ef-**

fect and generally it is not possible to permute them. This means that there must be in our notion of causality something fundamentally **irreversible**" (Ibid).

For a very detailed discussion of this question, see F. BONSACK's paper.

V.V. NALIMOV makes a very interesting study of the origins and history of determinism in its pre-logical and logical development (1981 b, p. 90-95)

0892

DETERMINISM (Epistemic)²⁾

The concept of **causality** according to which "given a complete **knowledge** of the present **situation** (Cf. the demon of LAPLACE)... if we assume that all **events** are causally related, and that **causal** determination is complete, then we must conclude that the world is completely determined and that all future **events** are in principle **predictable**" (1989, p.362).

This is the general frame of all scientific theories seeking grand **algorithms**, including the would be "theory of everything", embracing all forces in nature.

However, as stated by R.N. ADAMS: "Determinism is a condition where **events** conform to our **models** to a high degree, but it occurs because (1) the **models** are apt for the particular set of conditions and (2) those conditions are highly **stable**" (1988, p.3).

0893

DETERMINISM (Historical)→ **Historical determinism**

0894

DETERMINISM (Internal) (or self-)¹⁾

All **living systems** are endowed with some degree of internal determinism, as shown by P. VENDRYES (1942), who refined the concept previously developed by Cl. BERNARD in the second half of the 19th century.

The living **organism** adapts itself to the variations imposed by its **environment**, thanks to internal **cybernetic mechanisms** of detection and **regulation**. These count with available stored **reserves** which allow them to compensate internal **fluctuations** which result from these variations. VENDRYES gave numerous examples: the **regulation** of the body's content of glucose, respiratorial **rhythm**, lipids **metabolism**, etc.

The global internal determinism guarantees **dynamic stability** of the system and assures it a degree of **autonomy** in relation to **environmental** determinisms. This is thus a kind of **countervailing** determinism.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0895

DETERMINISM (Ontic)³⁾

Until now, we have used the word "determinism" in an **epistemic** sense: "A theory was said to be deterministic if all the **distinctions** made within that theory were **causally** conserved. Ontic determinism then should mean that we would infer from the determinism of our theory (e.g. classical mechanics) that the real world to which the theory referred were also deterministic (e.g. the world of LAPLACE)" (F. HEYLIGHEN, 1989, p. 379).

Conversely, concepts like **simultaneity** in relativistic terms, **bifurcations**, **emergence** or **chaotic attractors** lead us to a kind of **ontological agnosticism**.

F. HEYLIGHEN asks: "Is **causality** "real" or "objective", and does it exist independently of the **observer** (ontic interpretation)? Or is it merely a **cognitive construct**, an association between subjective ideas or experiences (**epistemic** interpretation)" (p.362).

"We would, hence, tend to conclude that the question of whether the world is (ontically) deterministic is a meaningless one, to which all possible answers are either trivial or unprovable in principle" (p.379).

→ **Ontological skepticism**

0896

DETERMINISM, RANDOMNESS AND CHAOS^{1) - 3)}

The chaos concept leads to a deep questioning of the traditional- and absolute- notions of determinism and **randomness**, whose relation has now become quite blurred. Formerly, in the words of J. GLEICK: "Either deterministic mathematics produced **steady behavior**, or random external **noise** produced random **behavior**. That was the choice.

"In the **context** of this debate, **chaos** brought an astonishing **message**: simple deterministic **models** could produce what looked like random **behavior**. The **behavior** actually had an exquisite fine **structure**, yet any piece of it seemed indistinguishable from **noise**" (1987, p.78-79).

Through **chaos**, **randomness** seems to become **embedded** within a broad determinism, or put in the opposite way, in **complex systems**, a kind of **determinism seems to emerge from randomness**. Either way, determinism and **randomness** become closely intertwined.

The **embedding** is quite clear in the WEIERSTRASS function for example, or in the **fractal** expressions of **chaos**.

However, these formalizations are still mathematical **models** and one may wonder if they fully contain the **interrelations** between determinism and **randomness**. For the time being, the subject must remain open.

→ **"ergodicity"**

0897

DETERMINISM (Statistical)²⁾

Overall determinism observed through a **behavior** characterized by unvarying probabilities (Adapted from W.R. ASHBY, 1981, p.202).

In E. JANTSCH words "A statistical determinism has to allow for **random deviations**" (1975, p.201).

Statistical determinism is difficult to differentiate from **deterministic chaos**.

0898

DETERMINISM (Structural)²⁾

The **set** of basic conditions that allows the **autogenesis**, existence and **survival** of a system.

According to HARNDEN: "Such a determination is a two way dance in that the unity structurally determines its **niche** in the same move that its niche **structurally** determines it" (1990, p.300).

In other words, any system is at least in some measure **preadapted** to its **niche-environment**: it is an unavoidable previous condition of **survival**. However, as no **environment** is ever absolutely **stable**, the system must repeatedly adapt and readapt to outside variations, within the **limits** allowed by its own internal **variety**.

Thus, structural determinism is a global **frame** for **behavior**. but necessarily admits more or less ample **fluctuations**, which may even appear as **random**.

In very complex evolutive systems (**ecosystems**, **sociosystems**) structural determinism becomes so vast and complex that it practically seems to dissolve, giving much leeway to innovation and **creativity**.

0899

DETERMINISTIC PROCESS²⁾

P. VENDRYES writes: "...a deterministic process can be fulfilled in one, and only one, way.

"This condition of fulfillment has two consequences: (1) the deterministic process is **predictable**, and (2) it is in principle **reversible**. Therefore there are three characteristics of a perfectly deterministic process: uniqueness, **predictability** and **reversibility**" (1989, p.148).

Of course, real processes are not that pure: they have **contexts**. In a system, any process is functional or, eventually, abnormal or pathological and, thus, submitted to conditions existing within the system. The same is true for processes connecting the system with its **environment**. Many **events** that may influence the process do not depend from it and, moreover will put **predictability** more or less in jeopardy when they become connected.

0900

DEVELOPMENT¹⁾

The progressive unfolding of a system's **structures** and **functions** until it reaches its mature **state**.

Development is one of the most confusing and abused term in common uses. It is quite generally understood as meaning an increase of some quantitative factor. However, it is also used in a qualitative **meaning**: the internal differentiation of **structures** and **functions** in a system. Even in this case, it can be generally measured in terms of **variety**.

According to M. BUNGE, and from a biological viewpoint, "the development **process** of an **organism** has three main strands...

"1. **Growth**, or multiplication of **cells** of certain kinds (at uneven rates for different **subsystems**...)

"2. **Morphogenesis**, or formation of new **subsystems**

"3. **Differentiation**, or specialization of **cells**

"All three aspects of development proceed under a triple **control**: enzymatic, genetic and environmental" (1979, p.95).

Genetic would be a kind of master-plan originated in inherited characteristics. *Enzymatic* would be a global internally harmonizing **regulation**. And *environmental* would represent the external varying **constraints**.

This **model**, as a whole, could probably be translated to **organizations** and **sociosystems** in general.

From a **thermodynamic** viewpoint, development is either related to the **growth** of a given system, or to its eventual **transformation** through **dissipative structuration**.

In the first case, only a moderate **growth** of a system well defined by its **organizational closure** is possible until the system reaches its **level of dynamic stability**, as defined by the minimal internal **entropy** production compatible with its **maintenance** necessities.

In the second case, the system is forced out of its **dynamic stability limits** by growing **energy inputs**, that must be **dissipated**, but may produce growing internal **structuration** and increase the **level** of internal **entropy** production. Eventually, the nature of the system may be radically modified through **emergent complexification**.

However, even in such a case the new system, after the **emergence transition**, needs stabilize itself, i.e. find its proper **level of dynamic stability**.

A system that should not be able to limit its **growth**, i.e. that would become over-developed, would be in great danger to destroy itself due to the exhaustion of its **environmental sources** and/or **overload** of its **environmental sinks**.

0901

DEVELOPMENT (Biological)^{1) - 2)}

According to F. BAILLY, F. GAILL & R. MOSSERI, the development of biological systems is submitted to the four following specifications:

1. **Endomorphism**: "...autonomy of an entity whose developing rules are internal and given once for all (genetic endowment), correlated and **organizational closed** (in the **autopoietic** sense- MATURANA and VARELA)"
2. **Discontinuity**: corresponding to a "development by way of alternating of **activity** and **latency**, critical **periods** and punctuated **sequences**"
3. **Recursivity**: "corresponding to a principle of informative economy by the application of only one formal law, reiterated at every step of the development"
4. **Nonlinearity**: "corresponding to the **process** of growing **complexification** paired with **iteration**...(a **linear iteration** would be merely **additive** and could not explain progressive, **structural** and **functional complexification**" (1991, p.58).

An example of **linear iteration** is crystal growth.

It would be interesting to consider the **validity** of these specifications:

- a) for the general problem of **evolution** (crf. GOULD-ELDREDGE's punctuated **evolution**).
- b) in the case of more or less integrated **social systems**, such as ant nests, beehives, enterprises, human societies.

0902

DEVELOPMENT IN HUMAN SYSTEMS⁴

R. ACKOFF emits the following opinions about development in **human systems**:

"By *development* I mean an increase in the desire and ability of the **organization** to satisfy its own needs and legitimate desires, and those of others... By *legitimate desire* I mean one which, when satisfied, does not impede anyone else's development.

"As 1) development requires motivation and **learning**, and 2) nobody can learn for another, one person or **social system** cannot develop others. The only kind of development that is possible is *self-development*" (1988, p.241).

This viewpoint is consonant with B. BANATHY's and the FUSCHL Group's concept of **co-participative social design**.

ACKOFF states moreover: "**Growth** is not necessary for development, however much it may facilitate development in some cases... In some cases, **growth** is a means to development but it should never be an end-in-itself" (p.245).

These views are in near complete opposition to the dominant socio-economic theories of the 20th. Century.

Another necessity for non-destructive development in human systems is that it be *balanced*. According to M.M. DODDS and G. JAROS, such a balance must comprise four fields:

- 1) **Collective consciousness**
- 2) **Environment**
- 3) **Collective abilities**
- 4) **Organizational configuration**

These authors write: "Incongruences amongst the four fields outlined above can be seen to create a **variety** of development problems on a global **scale**. These include, inter alia, imbalances between **population size** and the carrying capacity of the natural **environment**; between the aspirations of societies and their competence to achieve them; incongruence between the managerial capacity/organizational ability and the socio-economic and political **environment** in which the system has to function. These **activity** fields need to be brought into balance" (1994, p.1422).

However, and very unfortunately: "The irony is that it is every person's responsibility, yet no one has the authority to do anything about it, therefore no one is accountable" (ibid.).

The only ways out of this dead end is probably **systemic education for everybody** (centered on *realist ethics*)..., which could require centuries, and some types of globally evolved constraints on **human systems**, as they will possibly result from natural limits.

0903

DEVELOPMENTAL PROGRAM

→ Program (Developmental)

0904

DEVIANCE^{1) - 2)}

The slow **drift** of a system away from its basic functional conditions.

Such a **drift** may lead the system toward an **instability threshold**. This in turn may become a positive or a negative factor.

It is positive when it corresponds to a more or less automatic capacity of **adaptation to change**, as for example physiological **adaptation** to high altitude.

It is negative when it implies the appearance of useless or nocive **constraints**, as for example excessive bureaucracy in a society.

0905

DEVIATION²⁾

A departure from the normal **state** in a **homeostatic system**.

The **amplitude** of a deviation can be a good indicator of the **stability** of a system. For practical purposes, it should be closely monitored. I. PRIGOGINE and P.M. ALLEN write: "If it decreases in **time**, then the solution is stable; but

if it grows in **time**, then the **state** is **unstable** because the least little **fluctuation** will be amplified in the system and drive it away from the **stationary state**" (1982, p.9).

0906

DEVIATION – AMPLIFICATION PROCESS^{1) - 2)}

A process resulting from constantly repeated **positive feedback**.

This type of processes correspond to M. MARUYAMA's "**mutual-causal relationships** that amplify an insignificant or accidental initial kick, build up deviation and diverge from the **initial condition**" (1963, p.165). It easily leads to **runaway situations** or widening **fluctuations**, sometimes destructive or, in other cases eventually conducive to **dissipative structuration**.

MARUYAMA describes these processes as resulting from **positive feedback** and leading to **morphogenesis**.

However some caveats should be taken in account:

- Any **unchecked positive feedback** leads unavoidably to the destruction of the system because it rapidly overwhelms the capacity of the **environmental sources** to sustain the **process** (Fires, hyper-inflation, market crashes)
- Amplified **fluctuations** may lead to **dissipative structuration**, as in PRIGOGINE's **thermodynamics**. In this case, they lead to the **emergence** of a more **complex system**.
- In MARUYAMA's examples **positive feedbacks** are generally controlled by self-limiting reciprocal **rules**, *within a limited substrate*. A constant **source of energy** is not specified, but obviously necessary. These are the factors that orient and put **morphogenesis** on a defined track. Such processes are quite similar to J. CONWAY's **games of life**. As understood by MARUYAMA, and according to R.L. HOLLOWAY Jr. "Deviation – amplification adds the dimension of **time** and direction to... the generation of **structure** by incorporating the necessary **loop of positive feedback**" (1966, p.7).

0907

DEVIL'S STAIRCASE²⁾

A **discontinuous** mathematical curve characterized by many **steps**, some small or very small and some large or very large.

This curve was introduced by the German mathematician Georg CANTOR (1843-1918). It was considered for long time a paradoxical and imaginary invention.

However, P. BAK uses it now in his **self-organized critical evolution model** for an approximate **representation** of **punctuated equilibrium**, as a description of **discontinuous** mutation jumps in **evolution**, some small and frequent, some others big, but very unfrequent.

0908

DIAGNOSIS in systemic terms¹⁾

We are accustomed to diagnosis of **linear problems** of the type: "The car does not start because the battery is flat". This is not enough for intricate **problems in complex systems** (ACKOFF's "messes")

In such cases, diagnosis should be preceded by a wide inquiry about the multiple historical and present intertwined factors that could have a bearing on the **situation**. These factors must first be brought to light through appropriate mental techniques in **groups** wherein *all stakeholders* are present or represented. Thereafter, their **meaning** and relative importance must be debated and evaluated. And finally, the **constraints** and **synergies** that they introduce must be discovered and also debated and evaluated.

Short cuts in this procedure are always risky, even if admittedly **design** and **decision time** are in short supply.

Ill-informed **action in complex systems** generally lead to unforeseen resurgences of **problems** under new aspects.

For practical methods, see J. WARFIELD (1994b).

0909

DIALECTICAL SYSTEMS THEORY¹⁾²⁾

This peculiar systems theory has been progressively elaborated by M. MULEJ from 1974 on, and constantly researched by Mulej and his collaborators at Maribor University (Slovenia) from 1992 to date.

The most recent definition of the "dialectical system" is as follows: "DS is a system of all relevant and only relevant/requisite viewpoints systems" (Ecimovic, T. et al., 2002, section 4.1)

The authors are conscious of the difficulty to reach **consensus** about what is relevant or not, and discuss this point.

They describe their view of the Dialectical System as follows: "It starts from the notion that a system does not exist, but the **object** does, and the system reflects it, but partially: it exposes the part of object's characteristics, which is relevant from the viewpoint selected, only. Thus, a system is supposed to support **holism**, but it is fictitiously holistic in its own traditional definition:

1. From the formal mathematical viewpoints, a system is an ordered **set**, hence holistic.

2. In its contents, a system embraces only a part of the really existing characteristics, hence it is not holistic; its scope is limited to the view-

point(s)/ aspect(s) selected by the **observer(s)/ manager(s)** of the topic in question. DST defines holism as a system (=ordered set) made of

- **Systemics** (= consideration of the global part of the given characteristics of the **event**, object or **process** under consideration, i.e. in a **synergy/synthesis**), and
- **Systematics** (= consideration of the detailed part of the characteristics of the event, object or process under consideration per parts with no synergies, i.e. analytically), and
- **Dialectics** (= consideration of **interdependencies** among mutually partly equal and partly different or even opposing **elements** of the object, event or process under consideration, and of processes, which are caused by these processes and cause the **transition** from the sum of systematic characteristics of the object, event or process under consideration to the systemic ones), and
- **Materialism** (= consideration of **reality** rather than self-bluffing about the characteristics of the event, object or process under consideration)

Holism normally includes consideration of the environment of the event, object or process under consideration, of course. This is called an open system concept. The open system concept, on DST terms, does not simply include environment from the specific selected viewpoint only, but also a system of all different viewpoints, which might be relevant, essential for achievement of a **requisite holism**."

0910

DIALECTICS¹⁾³⁾

It is significant to know that this word has been directly transposed from the greek **language**, where "dialektos" is a "lektos"(saying) from one to another, "dia-", i.e. a **con-versation**.

Its original and basically **semantic** and psychological **meaning** became much ignored or obscured, first by its use in philosophy, and later on by its association with marxism. It thus acquired in the mind of many an ideological taint, that should better remain clearly distinct from its prior meaning.

Because of its significance as a basic **relationship**, it should nevertheless be considered one of the foundational notions in **systemics**.

0911

DIALOGUE^{2) - 4)}

B. BANATHY (as well as other authors) has explored systemic ways to use dialogue, specially in **co-participative design processes**. He distinguishes between Generative and Strategic Dialogue.

Dialogue (Generative) is a "mode of social discourse... applied to generate a common **frame** of thinking, shared **meaning** and a collective world view in a **group**"

"In generative dialogue people may prefer a certain position, but they are willing to suspend it. They are willing to listen to others in order to understand the **meaning** of their position. They are able to face disagreement without confrontation and are willing to explore points of view that they do not subscribe to personally..."

"Generative dialogue is not a tool for addressing specific task-focused issues" (1996, p.39).

"Generative dialogue becomes the core **process** of transforming the **group** into a "community" (p.40).

Dialogue (Strategic) "focuses on specific issues and tasks in organizational and social systems settings" (p.40).

BANATHY advocates "Generative dialogue + Strategic dialogue as a combined **methodology for Design conversation**"

→ **Conversation; Language; Language competence; Learning**

0912

DICHOTOMY^{2) - 3)}

The division of a **class** of **objects** or concepts in two mutually exclusive and generally opposite groups.

From a systemic viewpoint, this fundamental feature of classical logic should be used with care. The cases wherein only two clearcut opposite aspects do exist are quite exceptional. Dichotomies tend to arbitrarily reduce **complexity** in issues to oversimplified oppositions. Another caveat is that **binary logic**, whose dichotomic nature is obvious, tends to institutionalize such oversimplifications into the computational **process**, that may act as a straightjacket for **model** building.

0913

DICTYOSTELIUM DISCOIDEUM^{1) - 4) - 5)}

A species of amoeba which can switch from independent individuals to structured **colonies**, and reciprocally, according to **environmental** conditions.

This amoeba is a member of the Acrasiales, which consist of eight species. It offers interesting insights in the way **colonies** and societies may become organized, as well as the deeper significance of **crowding effects**.

J.T. BONNER's **description** of this amoebas' **behavior** can be thus resumed: The **cycle** will start when spores are sown in a sufficiently moist and nutritious **environment** for the bacteria on which the amoebae feed. After a time these start to multiply by division, thus producing numerous independent individuals. However, when the food supply nears exhaustion and the amoebae **population** is dense, they stop to multiply (probably a **mass effect**

caused by very close **interactions**). Some become centers of **attraction** for others and they start to **aggregate**. After two to four hours of a wavelike **process**, all the amoebae will be collected in cell masses of different **sizes** and acquire communal and integrated properties and **behavior**. The agent of **aggregation** is acrasin (cyclical adenosine mono-phosphate – cAMP), i.e. a biochemical product which through successive pulses, in a growing situation of **crowding**, becomes locally more concentrated and attracts the amoebae (**Chemotaxis**). At the end of the **process**, most of the amoebae are part of a unique **group**. The final specialized **role** of individuals within the **colony** depends on the timing of their **integration**. The aggregated masses of amoebae show differentiated and variable collective **behavior**, according to **positions** within the **whole**, but start to migrate as a **whole** toward light and heat, even if **gradients** are very small. Finally, if adverse **environmental** conditions persist, the aggregated mass will stop moving and produce a stalk tipped by a small sphere, where spores become formed. These spores will disperse and restart the cycle when favorable conditions reappear. Individual and collective **behavior** are thus much closely related than commonly believed. It is noteworthy that the **production** of cAMP is started by one single individual, possibly one more strongly affected by starvation than any other. The **process** then propagates to more and more individuals, in a way reminiscent of crystallization in a solution starting from a small nucleus.

According to BONNER, a quite complex division of labor becomes apparent, depending of the position of the individuals within the **colony**, i.e. related to their **positional value** (1955, p.104-110).

I. PRIGOGINE and A. BABLOYANTZ did study this **phenomenon** in terms of **dissipative structuration** (1972).

For details about the biochemical aspects and **models**, see A. WINFREE (1980).

Similar propagation **processes** seem to be present under different guises in:

- **periodic dissipative structures** in unstable chemical solutions
- propagation of fires, **avalanches**, pandemics, etc... (**percolation**)
- optical-electrical reactive collective **behavior** in fish shoals
- acquisition of resistance to toxic agents in bacteria and insects
- panics and mass behavior in human societies

In all these cases this social-type propagation is a **cyclical phenomenon** progressing in a **wave-like** way from one or more foci.

It would be very interesting to discover in each case the self-generated and reproducing stimulating **agent**, corresponding to cAMP.

0914

DIFFERENCE³⁾

A variation in **perception**, **behavior** or thought triggered by one or various **bits** of **information**.

The perception of a difference starts with the **observation** of some specific **discontinuity** between the **background** and the **object**. Any system is in this way separated from its **background** by the **observer**, as the first step to its study.

As to the way this is done, in BATESON's words: "... a single difference may be the yes-or-no answer to a question of any degree of **complexity**, at any **level** of **abstraction**" (1973, p.244).

→ F. HEYLIGHEN's concept of "distinction".

In the mental sphere: "A bit of **information** is definable as a difference which makes a difference" (BATESON, *Ibid*).

Thus, differences are not necessarily new in the **objects** or **elements** themselves, nor in the in-between **space**: they affect **relations** as they are perceived.

Indeed, **observers** (i.e. **self-referential systems**, **organizationally closed**), in E. STEINER and L. REITER's words: "... can refer only to their own **states** and the difference between these **states**" (1989, p.232).

0915

DIFFERENCES³⁾

The **distinctions** that can be made between various **objects** or **concepts** at the same or various **levels** of **perception**.

As noted by KORZYBSKI and BATESON, there are many kinds of differences. We have thus a problem of management of different differences, i. e. of **categorization** and **hierarchization** of differences. Finding out **rules** of **transformations** that can be applied to **classes** of differences is essential not only to be able to think in an orderly and useful fashion, but altogether, as emphasized by KORZYBSKI in "Science and Sanity" to maintain our mental (and possibly physical) health (1950).

0916

DIFFERENCES (Hierarchies of)²⁾

G. BATESON considers that what the biologists call "**levels**" (of **complexity**), as for example J. MILLER's 8 **levels** in **living systems**, mark hierarchical differences.

He writes: "These are the hierarchies of units or *Gestalten*, in which each subunit is a **part** of the unit of next larger scope" and he adds "... this difference or **relationship** which I call 'part of' is such that certain differences in the **part** have **informational effect** upon the larger unit, and vice versa" (1973, p.433).

In this case too, it is our mind which discovers a relation, being in this case an **embedding** ordering.

0917

DIFFERENTIAL EQUATION: limits to its uses^{2) - 3)}

These very significant **limits** are thus stated by A. RAPOPORT: "Both the strength and the limitations of the mechanical outlook reside in the mathematical **methods** used in the construction of **mechanistic** theories. The fundamental tool of this **method** is the differential equation which is essentially a precise statement about how certain quantities and their **rates of change** are related" (1966, p.3).

After reminding the role of second derivatives (the **rates of change** of the **rates of change**), he notes that: "If several bodies are involved... their motions would then be described by a **system** of differential equations in which the **relations** between the positions and the accelerations are all interwoven by a **network** of **interdependencies**. Now if the differential equations comprising a system are **linear**, i. e., if the **variables** and their **rates of changes** appear at most in the first degree, the same general methods of solution apply regardless of how many equations are involved" (*Ibid*).

This unfortunately, is a very special case, to which most **complex phenomena** cannot be reduced, lest the **model** would eliminate the very nature of the modeled system.

In celestial mechanics, for example, perturbations calculus can be superposed on a basically dual system (The sun and the earth for example – a **two-body system**), but with three or more bodies of comparable mass, the differential equations cannot be solved anymore (POINCARÉ) and we enter the realm of **deterministic chaos**.

0918

DIFFERENTIATION^{1) - 2)}

A growing degree of **heterogeneity** in a system or in a filiation of systems.

M. DODDS states: "In the evolutionary **process**, two tendencies which characterise all systems, viz differentiation and **integration**, go hand in hand. Differentiation is **variety**-increasing **behavior** (**morphogenetic**), leaning towards increasing **complexity**, apparent **randomness**, **fragmentation**, **freedom**. **Integration** on the other hand, represents **pattern** and **order**... The two tendencies are complementary, not contradictory" (1994, p.1417).

According to J.L.L.E MOIGNE: "The formalization of differentiation **processes** seems still uncompleted. Two types of **phenomena** may be distinguished: the ones - **morphostatic** - evolve by extension, by **regulation** or even by equilibration; the others - **morphogenetic** - evolve by **reproduction**, by **bifurcation** or by mutation" (1977, p.191).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The first type results from the progressive expression of the virtual characters of the system during the **process** of its **development**, characters that became inscribed in it at the moment of its **autogenesis**. In this case, the system undergo **transformations**, but maintains its **identity**.

The second type of differentiation leads to the **emergence** of systems endowed with a superior degree of **organization**. Evolutive differentiation is aided by **isolation** of different **groups**, but impaired by recombination: this seems also to be sometimes true for technical and cultural variation. This is not anymore mere **transformation**: it becomes **evolution**. It would be quite useful to coin different terms to express these two quite different **concepts** of differentiation.

Differentiation is, by its nature, **irreversible**, as it leads to increased **complexity** coupled with an increased **level** of **entropy** production.

0919

DIFFUSION²⁾

Progressive expansion of some **class** of **elements** from a high concentration **zone** to adjacent available and suitable **space** in their **environment**.

In many cases, diffusion leads to the shaping of dependent or independent new **clusters** or **colonies** of the **elements**. Diffusion produces a decrease of the local concentrations of the **elements**, but can be followed by a heightened **reproduction rate** of the same.

0920

DIFFUSION – COALESCENCE²⁾

A **process** through which a great number of scattered **elements** of the same kind tend to concentrate into tightening **clusters**.

Such **processes** can be observed in physics, but seem also to happen in some kinds of **living systems** as for example in *Dictyostelium discoideum*, in migratory locusts and even possibly in human **congeries**, like the modern megalopolis.

0921

DIFFUSION-LIMITED AGGREGATION²⁾

A mathematical model of numerous **processes** of patterned **growth** in systems.

(After M. BUCHANAN, New Scientist "Inside Science", Nr 121, p.4, 1999)

DLA is characterizing a great **variety** of **reaction-diffusion systems**, in which "**patterns** result from a basic **competition** between a **set** of forces that tends to amplify differences, and another that tends to dampen them out". (Ibid.)

An excellent example is the **Belousov-Zhabotinskii reaction** in chemistry..

→ **Dissipative structure**

0922

DIFFUSION-REACTION PROCESSES²⁾

A process that produces successions of receptive, active and quiescent **states** in **elements** (within an expanding diffusion-reaction process)

→ **Cyclic order**

0923

DIGITAL CODING⁵⁾

A **method** of coding using only two precisely defined **signs** indicating presence or absence, 1 and 0.

The basic logical **concept** of digital coding is **Boolean Algebra**. It is of universal use in so-called digital computers because it allows for the **sequential** treatment in a very short time of enormous quantities of **data** and instructions, previously translated into this **binary language**.

0924

DIGITAL COMPUTING⁵⁾

Computing based on the use of a **code** consisting of two **signs** or positions only.

Digitalization is the base of our actual computers, in contrast to **analogue** computing which uses continuous **signals** of variable intensity.

A. G. BARTO states: "Digital computing and **discrete models** are influencing our conception of real world systems and the role classical mathematics methods are to play in **modelling** them..." (1978, p.163). (See "**Dichotomy**").

Physicists, chemists, engineers, etc. accustomed to the successful use of **differential equations** "... have strongly developed intuitions in which continua and **rates of change** are powerful conceptual primitives. Those whose intuition has developed more directly under the influence of digital computing, on the other hand, find it very natural to think in terms of such concepts as **algorithms**, **data structures** and **automata**. In many applications of these **discrete concepts**, the availability of theoretical results is replaced by the computational power of digital computers" (Ibid).

This is really a very basic conceptual evolution, since, as noted by BARTO, "...actual digital computers can manipulate only finite **sets**" (p.164) of **discrete data**, while classical mathematics uses extensively the **continuity** and infinity concepts.

These two approaches are complementary rather than opposed to each other, but a clear **understanding** of their different nature is needed. See hereafter for more comments.

0925

DIGITAL SIGNAL⁵⁾

A signal coded in a **binary** way

The digital signal corresponds to **binary** or **Boolean** logic, i.e. a **coding** system wherein only two opposite positions are admitted as, for example, yes/no; or true/false, which can be represented by 1/0 or pulse/no pulse.

Digital signals imply necessarily a **discrete coding**, in opposition to continuous **representation**.

0926

DIGITALIZATION^{2) - 5)}

A **method** of **data processing** through which **information** from outside of the system, complex and **continuous**, is "cut" into **informations discrete** in **time** and **space** (J.C. TABARY, 1989, p.278).

J.C. TABARY writes: "The characteristics of the **receivers** do organize the "carving", not so the peculiarities of outside **information**" (p.278).

This is a most general consequence of the "**All or nothing**" principle.

0927

DIMENSION (Critical)¹⁾

Dimension below or beyond which a system is not anymore **viable**.

Any system corresponding to some defined type is unavoidably inscribed within **survival** conditions which impose to it a minimal dimension below which it could not have all of the needed **structures** and **functions**. Equally, beyond some maximal dimension the needs of the **communications**, **regulation** and **control subsystems** cannot anymore be satisfied, because sufficient **resources** are not available or cannot be transported. In both cases the resulting malfunctions lead to the demise of the system.

0928

DIMENSIONAL DOMAIN^{1) - 2)}

The **region** of **space-time** occupied by a system.

This term was created by A. ANGYAL (1941, in F.E. EMERY, Ed., 1969, p.21).

The dimensional domain is similar to a **topological space**, extended over the **time** dimension. Its characteristics are defined by the system within and it thus becomes differentiated from its **environment**.

According to ANGYAL: The dimensional domain is intimately involved in the formation of systems" (p.21).

It becomes defined through the **autogenesis process**, but it may grow and undergo internal **transformations**, within defined **limits**. The dimensional domain contains the systems **structure**. In ANGYAL's words: "A system is a **distribution** of the members in a dimensional domain" (p.25).

J.W. SUTHERLAND distinguished in a somewhat different – and more precise – sense:

- "the ecological dimension of the system which encompasses its "without";
- the domain dimension, which is its "within";
- the dynamic dimension "which is used to house any structural or functional **changes** which might occur between successive snapshots" (1974, p.131).

In this encyclopedia the term "**invironment**" is proposed for the domain dimension "within".

0929

DIMENSIONS (Physical and Mathematical)²⁾

G. MAYER-KRESS writes: "A very important **distinction** between the mathematical and the physical concepts of dimension is that mathematically the dimension is invariant under smooth **transformations** like deformations and **changes** of the coordinate system. If we take a ball of dough and roll it out to form a one micrometer thick pancake, then in a mathematical sense these are both three-dimensional **objects**. From a physicist's point of view, however, it might be important that the pancake can be treated as a two dimensional **object**. This apparent **change** of the dominant dimension plays a significant role in **dynamical systems** and **fractal chaos**.

"Dimensional arguments in physics have let to profound discoveries in, for example, turbulence, in **phase transition** theory and elementary particle physics, as well as in developing **renormalization** theory" (1988, p.357).

Of course, physical **fractalization** ad infinitum is impossible, because there are **changes** in the *nature* of the **elements**. **Parts** of a **complex system** may be **fractal**, but each **subpart** is generally itself another **complex system**, which in turn can be only partly **fractal**. At each **level**, the **parts** are of different kinds, for example **cells**, **molecules**, **atoms**, etc.

0930

DIMINISHING RETURNS (Law of) to scale^{1) - 2)}

K. BOULDING, having explained the relation between **growth** and structuration, explains why "the **size** of the **structure** itself is limited by its inability to compensate for the non-proportional **changes**" which is "the basic principle which underlies the law of eventually diminishing returns to scale".

Indeed, more and more **communications**, **regulation** and **control structures** are needed as the system grows, in order to maintain its **coherence**. These **functions** and **structures**, while essential for the transportation and allotment of **resources**, are not directly productive. Quite the contrary, they use up **resources** which are diverted from the productive **functions**.

BOULDING concludes that: "...these structural limitations bring the **growth** of the **organization** to an end" (1956, p.66-75).

Moreover, the excess of **complexity**, at least in human **organizations**, leads to a certain internal disconnection and the appearance of **subsystems** which in some cases, end up in an almost parasitical situation (for example authoritarian, uncontrollable and sterilizing bureaucracies).

H. ODUM sees that the law applies in **complex systems**: "... where the several **flows** of necessary **inputs** have a multiplicative **action** on the **input flow**. As any one factor is increased, it gradually passes through its limiting **range** to a plateau as other members of the **flow** become limiting" (1971, p.187).

As an example, D. PIMENTEL applied the **concept** to **energy** subsidized agriculture (not always direct, clearly visible, nor perceived) and shown its final **limits** (1977).

0931

DIPOLE²⁾

"The simple **black box** which has a single **input** terminal and also has a single **output** terminal" (M. BUNGE, 1979, p.254).

This a specifically cybernetic definition of a dipole representing "the simplest complete **black box** (which) is sensitive to **stimuli** of just one kind and accepts just one **stimulus** at a time... It acts just in one fashion on its **environment** and performs one **action** at a time... Any more complex **black box** is called a **multipole**" (Ibid).

0932

DIRECTIONALITY²⁾

Dynamic property of the logical **organization** of a system such as any **change** seems to aim at a **goal** in the future (in a **homeostatic system**, in a functioning **autopoietic system**, in a **tropism**, in an intention or objective) (adapted from E. SCHWARZ, 1993, P. 13)

SCHWARZ adds: "One could be tempted to oppose a causal system (whose present state is caused by its past) to a **teleonomic** system (whose present **state** seems to be conditioned by a goal). This would be an error, since the teleonomic property is itself causal, i.e. the result of the history of the teleonomic system" (Ibid)

So much for the science-fiction's time paradoxes!

0933

DIRECTIVE CORRELATION

→ **Correlation (Directive)**

0934

DISAGGREGATION⁵⁾

A higher **resolution level** in a **model**, that aims at showing more clearly **variables** considered as more elemental.

D. MEADOWS et al. write, referring themselves to the supposed practical benefits of disaggregation: "...every **modelling** effort is subject to severe **constraints** of **time** and **resources**. It is never possible (or desirable) to include everything that analysts – or others – think may be desirable. As a **model** becomes more detailed, **data** requirements, mathematical problems and overall **complexity** increase at a rapid rate. Detail can become a heavy burden when the time comes to debug the computer **program** or write documentation. Sometimes the decision to use a higher **level** of disaggregation results in excluding whole sectors or, perhaps limiting the time available for **validation**, **sensitivity** analysis, documentation or even actual use of the **model** to calculate results. It can also make the running of the **model** very expensive" (1982, p.101-2).

0935

DISASTERS: A systemic view¹⁾

Most disasters, in particular those concocted by men, have complex **causes**, are complex when they succeed and have complex consequences. They are thus a typical object for systemic research.

Complexity of **causes** is of two different orders:

- Numerous concurrent **causes** are generally necessary to bring about the disaster. The **understanding** of their progressive **interactions** is of paramount importance for **prediction**, reaction and mending. One specific **cause** must be considered with special care: the **trigger cause**, which also has its own **causes** (no **trigger**, no disaster...).
- **Causes** are connected with **processes** that turn **critical** at some **time**. However, not all of these **processes** are at the same **time scale**. It is of paramount importance to distinguish between the slow **accumulating causes**, at times on a secular or multisecular **process scale** and, at times on a much **shorter term**.

Complexity in itself is the result of multiple **interactions** among **processes**, some very basic, some other circumstantial... and many of them hidden or at least not readily visible. Only a good **knowledge** of these **interactions** can draw the attention to potential **risks** at specific moments.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

In many cases, **side-effects** of human **action** are also ignored, as research on physical **causes** generally shadows psychological, social, political, economic and even cultural ones. This ignorance is in itself a **cause** of disasters.

In synthesis, research on disasters, past or in the making, must be systemic.

→ **Cindynics**

0936

DISCINYM⁵⁾

"A word used to describe the specific case of an **isomorphic process** realized on one **scale** of reality, but which **maps** with many other cases, on other **scales**" (L. TRONCALE, 1985, p.76).

Since this neologism was proposed, it did not entered in wide use. TRONCALE gives the following example of a situation that would justify its creation: "... the use of "**homeostasis**" in anatomy (**note**: or physiology?) for the more general concept of "**dynamic equilibrium**". These diverse *disci*-plinary names for the same **process** or **structure** (**isomorph**) are *synonyms* for the **general systems** term" (Ibid).

0937

DISCIPLINARITY (Inter-, multi-, trans-) ¹⁾

R.L. ACKOFF states: "Nature is not disciplinary. The **phenomena** and the problems which nature presents to us are not divisible into disciplinary **classes**. We impose scientific disciplines on nature; it does not impose them on us. Some of the **questions** that we ask of nature – in contrast to the problems it presents to us – can be classified as physical, chemical, biological, and so on; but not the **phenomena** themselves... For example automobile accidents can be viewed at least as physical, biological, psychological, sociological, and economic **phenomena**. To study them in any one of these ways is to exclude **variables** relevant from other points of view" (1964, p.54).

This is of course not an anti-disciplinarian stand, but merely a caveat about **reductionist** blinders.

G. KLIR observes: "As a result of arguments pursued by **systems science** for decades, scientist are now becoming, in general, more sensitive to the limitations of their own disciplines. They tend to be considerably more aware now than a few decades ago that significant real-world **problems** involve almost always aspects that transcend disciplinary **boundaries**" (1993, p.51).

The subject of **interrelations** in-between specialized scientific disciplines is quite a difficult one. While the more generic term of cross-disciplinarity is frequently used, we propose the following distinctions in order to avoid the **semantic** muddle and the practical confusion which characterizes it.

Interdisciplinarity: indicates a specific **inter-relation** between two disciplines. Some examples could be: biochemistry, agrobiolgy, paleobotanics, astrophysics or astrodynamics and, in a somewhat extended sense economic history, population genetics or the comparative study of natural and artificial **neural nets**.

Multidisciplinarity: relates to a type of collective study of some complex project, in which specialists in numerous different fields must collaborate. Some examples are: the participation of economists, financiers, lawyers, engineers, geologists, agronomists, hydrologists, etc. into the planning of a great hydropower dam and irrigation scheme; or the global study of climate by meteorologists, oceanographers, physicists, chemists, vulcanologists, botanists, ecologists, etc.

Transdisciplinary: qualifies a set of general **methodologies** and **modelization** tools better adapted to study the numerous **interactions** and **feedbacks** within **complex systems**, as well as their significant exchanges with their specific **environment**. It applies to the same type of projects or **situations** studied by multidisciplinary endeavors, but it contributes tools for reciprocal **understanding**, discovery of hitherto unperceived **interfaces** and integrating synthesis

Interdisciplinarity: does not per se present many difficulties. It implies generally the bridging of two disciplines because one needs of the other or one brings new insights to the other. The astrophysicist, for example interpretes astronomical discoveries in physical terms and normally has an excellent **knowledge** of both fields and of the mathematics needed as lingua franca.

Multidisciplinarity: on the contrary brings along quite a number of misunderstandings. It reflects the ever growing need for collaboration among many (and very diverse) disciplinary specialists for the **planning** or the **management** of **complex systems**. Unfortunately, most of multidisciplinary meetings – especially those which must produce some critical **decisions** about practical projects – lead only to confusing misunderstandings and quite frequently to awful "**messes**" (in R. ACKOFF's words) and costly man-made **disasters**.

Transdisciplinarity implies:

1. The existence of a **meta-level** of **models** and **concepts**, leading to an integrated **synthesis**, constructed and understandable by all the **stakeholders** of the system under study (even those whose opinion has not been asked for).
2. The existence of a common **meta-language**, based on **isomorphies** and useful to convey synthetic **perception** of complex **wholes** and intricate **meta-models**.

No biologist will become an engineer, nor a geographer an economist, but they may thus reach a better mutual **understanding**, learn to ask "good questions" and to provide answers, meaningful not only for themselves.

General systemic and cybernetic concepts are preferred tools for transdisciplinarity

→ **the three corresponding specific headings.**

0938

DISCONNECTED COMPONENT ^{1) – 2)}

"A component which is only part of a system incidentally or is included only because it is defined so" (T.F.H. ALLEN & T.B. STARR, 1982, p.266).

ALLEN and STARR express: "There may be weak **interactions** between a disconnected component and other components of the system, but these are incidental to what is recognized as the normal functioning of the system and are not involved in the main lines of **communication** in system functioning" (Ibid).

An example could be the introduction of some secondary or temporary cultivar in an excessively **homogeneous** one in order to reduce pests propagation.

0939

DISCONTINUITY

→ **Continuous-discontinuous**

0940

DISCRETE or CONTINUOUS ? ^{1) – 2) – 3)}

W.S. IRVINE, in a review of D. GREENSPAN's "Discrete **Models**", writes: "Nature seems to abhor both a vacuum and a **linear response**". This is a very serious matter, since most of our **models** are **linear**, being based on the famous... **et ceteris paribus**, which in most cases is merely a comforting delusion of the **modeller**.

IRVINE observes: "Calculus evolved to handle a continuous system of equations, resulting from a series of discrete **observations**. Calculus provides continuous solutions that must be matched to discrete **observations** for verification. We tend to forget that calculus is a compromise at best, not an act of faith. When the equation system generated by the natural **phenomena** is too complex for calculus to provide analytic solutions, we often make assumptions and linearize until one can be found" (1978, p.131).

An imprudent use of this **method** may lead us to ignore, or worse, disclaim some seemingly aberrant **values** that could appear within an apparently **linear function**. It also may lead us to believe, if not in some fallacies of infinity, at least implicitly in that other and more subtle fallacy of accelerated and unchecked **growth**. This is surely one of our most questionable contemporary postulates.

A.G. BARTO writes on this same topic: "... a discrete **model**... might be formalized as a set of difference equations or as an **automaton**" (1978, p.164). **Automata**, indeed, show a discrete **behavior in time**. In contrast, "The term **continuous model** will refer to a system whose **time** base is the uncountably infinite set of real numbers".

Still: "The domain of a discrete **function**... is a **set** of integers. The **function** is not defined for real numbers between the integers" (Ibid., p.169).

We face thus a methodological **ambiguity**: our **selection** of a continuous or a discrete **model** always implies a basic definition about the **structure of space** and **time**. Such a definition is necessarily an unverifiable postulate.

0941

DISCRIMINATION ²⁾ - ³⁾

The act of drawing **distinctions**.

Discrimination implies separation from a heretofore indistinct physical, **conceptual** or **semantic environment**, through a newly acquired **perception** of a **difference**. It leads for instance to the identification (R.W. GERARD's "entitiation") of a system.

Perceptual discrimination is limited by physical and physiological conditions. The first ones are defined by basic physical constants (for example the quantum of **action**) and the second ones by the capacity of our senses to register specific **levels of action** (for instance sounds, but not ultrasounds).

0942

DISERGY ²⁾

A combination of **effects** that produces unsustainable or destructive results.

This is the contrary of **synergy**.

The possibility of disergies should be seriously researched and carefully watched, particularly in **human systems**, which are frequently managed in irreflexive and imprudent ways.

This neologism has been introduced by Rafael RODRIGUEZ DELGADO (1997, p.72) in a slightly different form ("Disenergy"). "Disergy" has been adapted here as more consonant with "Synergy".

0943

DISFUNCTION ¹⁾ - ²⁾

Uncorrect or impaired functioning of a **process** corresponding to a **subsystem** in a system.

Disfunction may be caused by **stress** or **wear**, which in turn result of **overload**, or on the contrary, insufficient **inputs** or **communication** failure.

Disfunction passes easily unnoticed in its initial **phases**, a potentially very dangerous **situation**. A frequent monitoring of **critical processes** in systems is needed in order to avoid sudden and unforeseen **disasters**.

0944

DISINTEGRATION ¹⁾ - ²⁾

A destructive **process** which breaks up the necessary **interactions** among the **elements** or **parts** of a system.

The disintegration **process** destroys the system by reducing it to an uncoordinated heap of disconnected **elements** and making it disappear as a significant **whole**. The **elements** do recuperate their total **independence** or, at least, even when they remain close to each other, are not anymore functionally **cooperative**. An example is the wreck of a sunken ship.

Disintegration results from the inability of some essential **part** of the system, generally some important **control system**, to perform its specific task. This may result from some irreversible damage or from the interruption of a basic **flow of inputs** or **outputs**. Some authors use the term "segregation" in the same meaning as disintegration (B. BANATHY, 1973, p.88).

When basic processes become impaired, the system endures growing **stress** that it becomes finally unable to counteract and loses any possibility to resist external **perturbations**. Most of its elements then disperse more or less randomly in the **environment**.

However, in some cases, some **structures** may resist destruction for a long, or even very long **time**: examples are animal and vegetal fossils, skeletons, ruined historical buildings and even so called dead **languages** as egypatian hieroglyphic language or sumerian cuneiform

→ Ageing; Aura; Autopoiesis; Decay; Entropy production (Minimum); General adaptation syndrome; Inenvironment

0945

DISJUNCTION PRINCIPLE (D.P.) ¹⁾²⁾

Global **determinism** is not possible because of the non-instantaneous character of **interrelations** propagations.

This derives in fact from **relativity** theory and the multiplicity of **simultaneous events** in different places.

It explains why Laplace in his famous enunciation of universal and absolute determinism (R. PASSET, p. 33) must introduce an universal and omniscient intelligence.

Of course, such an intelligence does not exist in any known living being of the past or the present.

It is however to be noted that the very disjunction principle is in itself...disjoined

In effect the "coefficient of disjunction" (i.e. the time needed for the propagation of **effects** between various **entities**) is different in all cases. Andromeda galaxy is more disjoined from us than the sun and the sun more disjoined than the moon.

The D.P. is also at the root of **chaotic determinism** and has basically a **time dimension**.

As such it must have some **connection** with **thermodynamics**.

This is a mere preliminar exploration of the subject whose consequences could be far reaching (and possibly very controversial)

0946

DISORDER ¹⁾ - ²⁾

A general **state** of lack of **coordination** between **elements**.

It would possibly be better to create a neologism for such a **state**, for example "unorder", because in common **language**, disorder really means "seriously altered order"

It is obviously in such a dubious way that R. FIVAZ understands disorder when he defines it as an "arbitrary arrangement in **time**, **space**, velocity or other dimension of positions of **elements** in a system: the arrangement is such that positions in any **part** of the system cannot be predicted from the **knowledge** of positions in any other **part**" (1991, p.31).

It seems however clear that "arrangement" and "disorder" are compatible terms only if disorder is not total.

In accordance with **thermodynamic** laws, disorder means "a completely featureless **distribution of elements**", which corresponds to the **state** of maximum **entropy**, and **random distribution** and movements of the **elements**.

This is a generally **final** situation and, in case of systems the "end of the road". As St. BEER once said: "Death is **equifinal**".

As in a disordered **state**, no **constraints** exist, or in other terms no **algorithmic compression** is possible, the quantity of **information** that would be needed to describe it is maximum. This is the reason (questioned by some authors) why **information** is many times quoted as corresponding with so-called "**negentropy**".

Chaos theory introduces the **understanding** of a different kind of disorder: the general **unpredictability** resulting from complex **dynamics**.

0947

DISPERSAL ¹⁾ - ⁴⁾

The capacity of **elements** present in an optimal microsite to migrate to other ones.

This is an important feature for the reconstitution of **ecosystems** that have been affected by a **disturbance**. It may as well be important for **human systems** partially destroyed by some **disaster**. In France, for instance, after the Black Death pandemics (1347-1352), artisans were brought over from Italy in order to reimplant some disappeared specialized trades.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

0948

DISPERSAL RATE ²⁾

The rate of **propagation** in **space** of some type of **elements**.

Dispersal rates depend on:

- specific characteristics of the **elements** which are favorable or unfavorable to **dispersion**
- the general conditions of the **environment**, which can be: a) different in different directions (**anisotropy**)
- stable or unstable in **time**, as for example in case of **cyclical** or irregular climatic change.

0949

DISPERSION ^{1) - 2)}

Capacity of a **complex system** to detect, either simultaneously or in an alternative way, some **inputs** or **stimuli**, by way of different perceptive and transmissive **subsystems**.

ASHBY, who introduced this notion, gives the following examples:

"The point to point **representation** of the retina on the visual cortex, for instance ensures that the dispersion achieved in the retina will at least not be lost (1960, p.180).

"...if a beam of radiation of wave-length $0,5\mu$ is directed to the face, the eye will be stimulated, but not the skin; so the optic nerve will be excited, but not the trigeminal. But if the wave-length is increased beyond $0,8\mu$, the excitation changes from the optic nerve to the trigeminal (p.179).

In other words, dispersion enhances adaptive polyvalence.

0950

DISPERSION (Controlled) ²⁾

S. BEER introduced in 1966 a different **concept** of dispersion: the progressive branching of some **process** in the **time** dimension, with the corresponding variable **interactions** in-between different effects of the initial **cause** or causes.

He described graphically his **model** through a **tree** arranged along the **time** dimension, which he calls "dispersing stochastic network" (1968, p.180).

In the light of the **deterministic chaos model**, "stochastic" takes on a deeper **meaning** since it could now be added that any **network** flowing through **time** is bound to be dispersive, but within the **limits** of **coherence** proper to the **network**, according to its **interaction rules**. This makes BEER's model still more insightful.

→ "Convergence (Controlled)".

0951

DISRUPTION ¹⁾

The breaking asunder of any system by the destruction of one or various of its regulating devices.

Regulators are **circuits**, based on **feedbacks** and composed of two or various interconnected **arcs**. Cutting one of these **arcs**, or even only mishandle it, may disorganize or destroy the whole system.

This is frequently the case when mere consequences are confused for **causes** in **complex systems**. A good example has been the HWO campaign to eradicate paludism through insecticide spraying against anopheles, and synthetic drugs use against the plasmodium, without taking in account that paludism is part of very complex ecological systems, including waters, plants, animals and human settlements of great **variety**. Moreover, the **co-evolutive** ability and **adaptiveness** of the intervening species also were ignored. As a global result, paludism is presently out of **control** in expanding zones.

In G. BATESON's words: "Characteristically, **errors** occur wherever the altered causal chain is part of some large or small **circuit structure** of a system. And the remainder of our technology (of which medical science is only a part) bids fair to disrupt the rest of our **ecology**" (1973, p.119).

The disruption problem is a typical result of partialization in the **management** of systems of any kinds.

0952

DISSIPATION ^{1) - 2)}

The **rate** at which **entropy** is produced by an **energy** fed system.

Dissipation is concomitant with the existence of **nonequilibrium** conditions within **concrete systems**.

Energy can be dissipated in three different ways:

1) "by microscopic **interactions** between entities in a virtually **homogeneous** or "incoherent" **field**" (F. ROBB, 1990, p. 138). This type of dissipation is dealt with by the purely **abstract model** of **entropy growth** in **isolated systems** (i.e. deprived of **inputs**) proposed by classical **thermodynamics**.

2) According to PRIGOGINE's theorem of **minimum entropy production** in **homeostatic systems** at a given **level of complexity** and in their **state** of maturity. This is thus expressed by M. CEREJIDO: "The system tends toward **structures** which will permit it to maintain its **entropy production** at the lowest possible **level** (until it reaches) more equilibrated **structures** with the minimum dissipation" (1978, p.97). This is L. ONSAGER's *Minimum Dissipation Principle*, according to which replication of systemic **structures** has a lower **entropy cost**

that creation of new **structures** by dissipation (1931, p.405-26). This is consonant with the acquisition of **stability** by **autopoietic systems** as well as with BÉNARD's **dissipative structuration**, once the system stabilizes, and **structures** are only **maintained** through a minimum dissipation **rate**, or least dissipation, regulating the **energy flow** to a minimum compatible with the system's **survival**.

This kind of dissipation is proper to systems submitted to **wear**, and end by final **break-down** (see "eigen time").

3) "by the **emergence** of a new higher **order entity**, a "coherent" **field** which dissipates even more **energy** (by increasing the area of the dissipative surface)" (F. ROBB, 1990, p.138). R.N. ADAMS in turn, writes: "The dissipation of expanding systems increases the amounts and varieties of **energy** forms being incorporated and thus also the low- quality **energy** and **waste** material eliminated or marginalized because it cannot be processed inside the **structure**. Hence, dissipation not only creates areas of **control** (certainly within the **structure**, and sometimes outside it) but also creates areas beyond **control**... Thus the act of dissipation creates in the **environment** new dynamic factors in natural selection" (1988, p.136).

In the second as well as in the third case, **dissipative structures** must sustain themselves in a dynamic way by permanently obtaining from a specific **environment** the needed **energy inputs**. As observed by R.N. ADAMS: "For them construction and destruction are simultaneous. In **organisms**, old **cells** dissipate while new **cells** are formed; in societies, people die and are replaced by new people who are taught by the old" (p.60).

Systemic **complexity** is proportional to **energy** dissipation. Or, in other words, systems are **entropy** accelerators and the more complex ones are the strongest accelerators.

Of course, any system depends on its **environment** to obtain the **energy** it needs for dissipation and, *globally*, the **2nd. law of thermodynamics** is respected, even if locally, within the system, a more complex degree of **organization** appears.

As to the ultimate nature of dissipation, it seems to be some sort of general cosmic **dynamics**. The rumanian physicist S. LUPASCO (1900-1988) who developed his views in France, sees this cosmic dynamics as reflected into the opposition between the **2nd**. Principle of **Thermodynamics** (which prescribes the unilateral and irreversible degradation of the quality of **energy**) and PAULI's **Exclusion Principle**, according to which any two particles can never have their four basic quantum numbers identical (1974). This prescribes obviously a very basic condition for the **organization** of the material world, that LUPASCO describes as "energetic antagonism".

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

Such an antagonism is clearly visible in the genesis of material **forms** (D'Arcy THOMPSON, 1916, Ch. Laville, 1950)

→ **Entropy production** (Theorem of Minimum); **Fields** (Interactions between); **Form and Force**; **Morphogenetic field**; **Structure** (Dissipative); **Symmetry breaking**; **Vortex**

0953

DISSIPATIVE STRUCTURE

→ **Structure** (Dissipative)

0954

DISSOLUTION OF A SYSTEM^{1) - 2)}

Ch. SMITH resumes E. JANTSCH's synthesis about a system's dissolution in conditions of **turbulence**. Associated conditions and **processes** are as follows:

"a) **Initial conditions of disequilibrium** – through a system's opening to internal or external forces of **turbulence**. Forces moving a system toward **disequilibrium** must be sufficiently intense or be stepped up to a degree that they act to push the system out of its **equilibrium** maintaining or stabilizing **parameters**.

"b) **Symmetry breaking** – involving a system's breaking down of its **structures** and **processes** – (must reach) to an extent that sufficient **degrees of freedom** become available as a capacity within which new **structures** may be formed" (1986, p.206).

Of course, many systems are utterly destroyed by **turbulence**, never getting any chance to reach a higher **level of organization** by **dissipative structuration**.

In these cases, their **elements** are set free and may become **parts** of new systems. This has been the case, for example, of members of archaic tribes who individually survive the destruction of their society and are incorporated at least biologically in another culture, carrying over with them some genetic and cultural traits.

0955

DISSYMMETRY^{1) - 2)}

Uneven **distribution of energy** or **matter** in **space** and in **time**.

This notion was introduced by L. PASTEUR (dissymmetry of tartaric acid crystals) and has taken a growingly general character. It seems to be related to **dissipative structuration** and **emergence of complexity** in systems and, consequently with **thermodynamics of irreversible systems**.

A dissymmetric **concept** of the **effects of entropy** is now also basic in H. SABELLI's **process theory**, according to which all **processes** and **concepts** imply two opposite **dynamics** or **forms**.

0956

DISTANCE (Critical)^{1) - 2)}

The distance at which formerly isolated **elements** start to interact or formerly interconnected ones become totally independent from each other.

(Also called "Correlation distance, or length")

This intriguing notion is undoubtedly present from the subnuclear **level** up to the most global social one.

Critical distances depend on "forces" acting through **space** and **time**, in ways generally quite difficult to explain. Moreover, there are **interaction thresholds**, specific for every kind of **interactions**, be they subnuclear weak forces or human **communication nets**.

Crowding (or scattering) seems to be always the **trigger** factor, but this concept is nearly tautological with the "critical distance" one.

In any case, no **complex system** may appear, nor subsist when distances between **elements** do not allow for more or less frequent **interactions**.

The concept evokes very basic questions about the nature of **space** and **time** and their relative **meaning**.

0957

DISTINCTION³⁾

A relation between **phenomena** which is conserved in a bijective way even if the **phenomena** themselves change during the **process**.

This **concept** has been discussed by J.A. GOGUEN and F. VARELA who state: "A distinction splits the world into two parts, "That" and "This", or "environment" or "system", or "us" and "them", etc. One of the most fundamental of all human activities is the making of distinctions. Certainly, it is the most fundamental act of systems theory, the very act of defining the system presently of interest, of distinguishing it from its **environment**. Distinctions coexist with **purposes**". (1967, p.32) The corresponding logical **model** is based on SPENCER BROWN's distinction algebra (1969)

It is also useful in order to differentiate causal and stochastic **processes**, as well as reversible (retrodictable) or **irreversible** (and more or less **predictable**) ones.

HEYLIGHEN states: "To be meaningful, a distinction must have a minimal **stability** or **invariance** (i.e. during (certain) dynamical evolutions it must either remain constant or be mapped on another distinction)" (1989, p.382)

"A distinction is constructed by the **observer** in **interaction** with the system. As such, a distinction is always to a certain degree subjective, depending on the **goal** the **observer** has in mind while modeling the system, but is not arbitrary, because not all distinctions will allow the **observer** to find **coherence** between the different **observations** performed on the system. Since all **phenomena** in the universe are

by definition different, the number of potential distinctions is infinite. A **representation** of (part of) the universe is necessarily finite, and, hence, the number of distinctions an **observer** will make will be infinitely smaller than the total number of distinctions he or she could make" (1990a, p.427)

The preceding comment is specially significant for human sciences.

In effect, any psychological or social distinction- much more than distinctions in hard sciences- is always made "in situ", i.e. in some specific observing way allowed to the **observer** by his/her culture (D. BAECKER, on LUHMANN's "sociological enlightenment", 1996, p. 5).

It is thus very important to try to solve what BAECKER calls the "problem of **latency**", i.e. find ways to discover (distinguish!) "the manifest from the latent and thus "double" the world in two versions, a visible one and a hidden one" (Ibid, p. 8)

According to G. SPENCER BROWN (1979) "... a distinction is drawn by arranging a **boundary** which separates sides so that a point on one side cannot reach the other side without crossing the boundary"

For a critical study of SPENCER BROWN's concept, see R. GLANVILLE "Beyond the boundaries" in ERICSON, R. (Ed), 1979

E. SCHWARZ made however the following- and quite disquieting- comment: "Distinction...- which is a necessary prerequisite to making pertinent scientific **models** of the world, has led to the radical separation of the **objects** (and of the forces) found in the **mechanistic approach**; the exaggeration of the **separability** of the mechanistic approach; the exaggeration of the separability of things prevents us to be aware of the dense **network** of **relations** between the **events** of the sensible world. Many of the contemporary concrete problems of our technological society (ecological, economical, social, etc) are due to the neglect of the **web of interconnections** between the **phenomena**".

He adds: "It seems to us that the thought of David BOHM is a crucial step toward a reconciliation between the necessity to make distinctions in order to recognize the **configurations** of the world around us, and the need to be conscious that we are a non-separable part of the world" (1999, p. 138-139)

→ **Separability; Wholeness**

0958

DISTINCTION (Primary)²³⁾

The most elemental distinction that can be made. D. HERBST writes: "When a distinction is made, a **boundary** comes into being together with the inside and the outside of a **form**. What is generated in this way is a triadic co-genetic unit consisting of the inside, the outside and the distinction made, which is represented by

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

the boundary. At this stage, we have nothing more than a form in an empty **space**"(1993, p. 29)

Examples are a line (or a circle) in an empty two-dimensional surface, or plane.

Herbst adds: "In its most general form, what has become generated...is a unit consisting of not less than three **elements**"(Ibid)

This is in fact the basic **triadic** unit, related in different ways to Ch.S. PEIRCE's "thirdness" and to SPENCER- BROWN's **laws of form**.

Any distinction is also an **operator** in the meaning developed by R. VALLEE (1995)

→ **Dyad; Network; Topology; Triad; Triadic relation; Triadicity**

0959

DISTINCTIONS (Cinematics of) ³⁾

According to F. HEYLIGHEN, "The cinematics of distinctions can be viewed as a general **description** of possible **processes** involving distinctions. For a given type of distinction there are four types of **processes**:

"1. Conservation of the distinction: This can be modeled by a one-to-one, **bijective function**, corresponding to a **process** reversible and **predictable**" (1990a, p.427).

The author probably means that past **states** of the **process** confirm the distinctions.

"2. Destruction of distinctions, but without creation of new ones: This can be modeled by a many-to-one, surjective **function**, corresponding to a **process** **predictable**, but **irreversible**

"3. Creation of new distinctions, together with maintenance of the existing ones: This can be modeled by a one-to-many relation (not a **function**) corresponding to a process reversible but not **predictable**" (It is not clear in which sense such a **process** could be reversible).

"4. Creation of distinctions together with destruction of distinctions: This can be modeled by a many-to-many relation, corresponding to a **process**, irreversible and **unpredictable**" (p.427-8)

0960

DISTRIBUTED MEANING (Principle of) ²⁾³⁾

The complete characteristics or **meaning** of an **element** in a **set** of interconnected **elements** cannot be completely guessed from that single **element**.

This principle is a direct consequence of the system's nature, being the **interrelations** and **constraints** as important as the proper qualities of any **element**.

The principle is very general. For example, in any word, composed of sounds and syllables, "the acoustic **cues** for each sound (are) distributed across the entire word" (Ph. LIEBERMAN, 1997).

In the same way, the shades of meaning of a word in a sentence can be wholly perceived only within the sentence, and even in some cases within the whole **context**.

The same is true of cultural **elements**, whose more significant meaning can be captured only within a social **behavior**, as for example a **ritual**.

→ **Memory (Distributed)**

0961

DISTRIBUTER ^{1) - 2)}

"The **subsystem** which carries **inputs** from outside the system or **inputs** from its **subsystems** around the system to each **component**" (J. MILLER, 1978, p.3).

The distributor is one of the **20 critical subsystems** in J. MILLER **taxonomy of living systems**.

0962

DISTRIBUTION ²⁾

"The relation which is **commutative** and **intransitive**" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.33).

Grains of sand in a dune do accumulate in a **commutative** way, as the **order** in which they accumulate is irrelevant. Moreover, since they are directly in contact (i.e. without any sequential ordering), their distribution is not **transitive**. This implies that there is no **structure** of any kind.

However, distribution as defined by FEIBLEMAN and FRIEND is a primitive and rudimentary form of **coordination** between **elements**: An **environmental** force, the wind, modifies at any moment the distribution of the grains of sand on the dune. No distribution of this kind becomes more significant than any other, at least if the **environmental** force shows a strictly **random behavior**, which is seldom the case in concrete situations.

0963

DISTRIBUTION (Clustered) ^{1) - 2)}

H.T. ODUM writes (referring himself to **ecosystems**): "Individual plant species are not evenly spread but are concentrated in zones according to their specialized **adaptations** to local conditions. More than one species is interspersed in the same kind of **environment**, because **networks** need diverse pathways... **Random** distributions are rare" (1971, p.72).

ODUM observes, moreover, that **consumers**, such as "ants, antelopes and people" tend to become clustered, "... because their complex **functions** are favored by grouping" (Ibid).

All this is related to the ways **flows** of **energy** circulate within the **environment** and to their progressive concentration into systems of a higher **level** of **complexity**, which prove more apt to capture them.

The concept is related to LOTKA's '**world engine**' and to **hexagonal distribution** in human settlements.

0964

DISTRIBUTION (Fractal) Law ²⁾

The number of **elements** is in inverse proportion to their **size**.

This is not absolute, but it applies nevertheless to many sets of **elements**. An example is the number of asteroids in relation to their **size**.

0965

DISTRIBUTION (Hexagonal) ^{2) - 4)}

A distribution characterized by the shaping of hexagonal **structural** and **functional nets**.

The hexagonal distribution model has been proposed from widely aparted quarters.

It appeared in hydrodynamics in BÉNARD's **dissipative** cells **structures**, which are produced in a boiling liquid through convective currents resulting from differences of temperatures when the liquid is heated up to boiling point in a vessel.

Dissipative structures (not necessarily hexagonal) became later on a very important tool in **Thermodynamics** of **systems far from equilibrium**.

This type of description was also introduced by W. CHRISTALLER (1933, 1937), describing the **embedded** and concentric hexagonal **nets** which appear in many human settlements. This theory was considerably extended by A. LÖSCH. (1944). See "**Hexagonal space filling**".

The reasons explaining hexagonal distribution are now clearer: in an **isotropic space** various competing **dissipation processes** in reciprocal contact adopt an hexagonal repartition seemingly because it is the most efficient manner to occupy space. However, as no **space** is absolutely **isotropic**, the **model** is only an approximation.

0966

DISTRIBUTION (Hierarchical) ^{1) - 4)}

The result of the progressive **propagation** of a **phenomenon** or **process** around one or various original centres.

The original centres of diffusion actuate as kinds of permanently active **sources** producing **elements** that will progressively migrate at growing distances and eventually generate secondary centres.

Such secondary focuses are generally produced by a discontinuous jump at a distance of some isolated **elements**.

The **process** will eventually lead to the **saturation** of wider and wider areas.

This very general **model** can be used for quantitative modelization of many different **processes**, as for example:

- propagation of epidemics or pandemics (P. GOULD and R. WALLACE, 1994)
 - expansion of **urban systems** (P. ALLEN, 1982)
 - progression of invasive vegetal and animal species
 - diffusion of technical innovations.
- **Percolation, System (Composite)**

0967

DISTURBANCE¹⁾

1. "That which displaces, ... moves a system from one **state** to another (W.R. ASHBY, p.77, 1956).
2. "Any relatively discrete **event** in **time** that disrupts **ecosystem**, **community** or **population structure**, and changes **resources** availability of **substratum**, or the physical **environment**" (St. PICKETT & P. WHITE, 1985 – as quoted by S. REICE, 1994, p.427).

While ASHBY's definition is more general, the second one is more useful in relation to **concrete systems**.

REICE states: "This **description** defines disturbance as a physical **event**, not as the biotic outcome of the **event**. I view a disturbance as a physical force such as a fire, flood or tornado that damages natural systems... The first impact of a disturbance is always to remove **organisms**" (Ibid).

This concept can easily be extended to an ample **variety of human systems**.

REICE adds various interesting comments: "Disturbance is **scale** dependent. If the area studied is large enough or the **period of observation** long enough, all disturbances are **predictable** and "normal" (Ibid). This means, of course, **relatively predictable**"

Still: "At smaller **scales** or shorter durations, disturbances appear completely **random**" (Ibid).

Moreover: "The **absence** of **predictable** disturbances (for example, spring snowmelt floods, or the arrival of snow in winter) often has a greater impact than their presence" (Ibid).

REICE refers himself to "disturbance **regimes**", which may command frequent, intermediate or only **long term** disturbances. Under the former one, "...the dominant competitors are reduced or eliminated, and colonizing species (assumed to be inferior competitors) dominate the system" and, "...under a disturbance **regime** that is intermediate in **frequency**, **magnitude** and intensity, some resident species persist in the system, along with colonizing species, which exploit the disturbed areas. Thus intermediate disturbance leads to maximum species richness" (Ibid., p.428).

Finally, long delayed disturbances tend to lead the system to a kind of **ageing**, with decrease of **variety (diversity)**.

However, "Disturbance *per se* does not determine **diversity**. It (only) creates opportunities for colonization of vacated **spaces** by new species" (p.431) ... of course if these are available from other **zones**.

Moreover: "Spatial **heterogeneity** and disturbance are interdependent. Disturbance creates patches, but **parchiness** modifies and sets the extent of the disturbance, – that is disturbance responds to the underlying **heterogeneity** of the **environment**" (p.434).

Generally speaking systems show **adaptability** to disturbances.

A last important aspect is that : "In some systems the return **frequency** of disturbance is so long that the impression of **equilibrium** conditions develops. This is what underlies the traditional idea of **climax communities**".

These very significant **models** should be pondered by anybody who wants to interfere with natural **ecosystems**. Their **validity** should as well be considered for **modelling** disturbances of **human systems** and their reactions to these.

It is important to note that disturbances can be **endogenous** or **exogenous**, even if an environmental disturbance is generally the remote or direct cause of the endogenous one.

0968

DIVERGENCE²⁾

The progressive differentiation and separation of **processes** in a system.

Divergence leads to the decrease of **interactions** among some **parts** of the system and is characterized by the slackening and possible final rupture of internal **communication**.

Divergence may lead to the break-up and **dispersion** of the system into unconnected **parts**.

Divergence and convergence

In a different **meaning**, as the opposite of **convergence**, divergence is the progressive **drift** of a **process** away from its planned **development** and may lead to great losses of **resources** and **time**. In any planned **process**, permanent or iterative **monitoring** of divergences should be provided for.

0969

DIVERSIFICATION¹⁾

The progressive increase of **variety** in systems.

Diversification seems to be a general property of evolving systems. Stellar systems, vegetal and animal species, individual **living systems**, **ecosystems** and **sociosystems** become more differentiated in **time**.

This seems a result of their **development** in at least three interconnected aspects:

- original constitution which offers them a specific potential for acquiring **variety**.

- original constitution which offers them a specific capacity for absorbing increasing **inputs** of **energy**.
- environmental conditions which allows for some **adaptations** or **transformations**, but inhibits others.

This last condition is the one which establish final **limits** to diversification.

0970

DIVERSITY^{1) - 2)}

The presence of different types of **elements** in a system, or of systems in an **environment**.

This is a quasi-synonym for **heterogeneity**, or in a slightly different sense, for **variety**. Diversity is a condition for "check-and-balance" and helps to maintain **dynamic stability**. As noted by J.T. BONNER it can be viewed as a measure of **complexity** (1988, p.101). Man is presently suppressing much natural diversity and is thus engaged unconsciously in a possibly dangerous experience. It is however for the moment impossible to judge the possible results of the artificial diversity he is introducing through, for example, genetic engineering, **artificial intelligence**, etc., all of which can be considered as **disturbances**, in a very general sense.

A wider definition refers to the presence of numerous different types of **elements** in some extension of **space**.

Diversity results basically from the slowing down and more complete use of the potential of **energy flows**. This is obvious in the mean-dorous circulation of energy in ecosystems (A. LOTKA's **world engine**). It may however even be the case in cosmic, stellar and planetary diversification. LAVILLE's **subdividing vortexes** and STULMAN's **fields within fields** are related subjects.

A cybernetic theory of diversity has been constructed by W. Ross ASHBY, under the name of **variety**.

An important degree of diversity is a basic condition for **dynamic stability** in **ecosystems**. Thus the present massive elimination of many kinds of natural animal and vegetal species by man is probably conducive to a greater general **instability** of all **ecosystems**.

C. WILLS writes: "Safety lies in diversity, and **evolution** should increase this diversity" (1996, p.41)

Range of diversity

J. WARFIELD uses the concept of diversity in his "**Interpretive Structural Modeling**" and in his "**Generic Design**" methodology to measure the **range** of diversity of beliefs and ideas in any **group** participating in ISM or GD.

He uses a **scale** from 1 to 10 to measure the degree of agreement or disagreement among participants on **evaluations** and ideas. A diversity range of more than 5,0 is quite frequent

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

and shows that disagreement is more common than **consensus**. This **knowledge** is important to avoid **underconceptualization** by a superficial assessment of **situations** and opinions.

0971

DIVERSITY GENERATOR ²⁾

Any device which introduces new **variations** within a system.

A diversity generator produces generally **random** variations. Such a device is about the opposite of ASHBY's **variety reductor**.

It is basic for **evolution**, because some variations can be useful and be retained by **selection**.

0972

DIVERSITY INDEX ²⁾

A measure of diversity created by SHANNON and WEAVER.

Diversity indexes take in account the number of different **classes** or types and the number of **elements** per type. Diversity indexes are widely used in **ecology** (S. REICE, 1994, p.428).

0973

DIVISION OF LABOR ⁴⁾

In any socialized **group**, the subdivision into distinct subgroups for the carrying out of some specialized **tasks**.

The original idea was developed by Adam SMITH in his "Wealth of Nations" in relation to **Economics** (1776).

However it is now clear that division of labor is a very general societal property. It can be found in insects societies and even in slime molds (*Dictyostelium discoideum*) and in some bacterial **colonies** (Anabaena) (J. SHAPIRO, 1988)

0974

DOMAIN ^{1) - 2) - 3)}

"A closed **universe** of existence which we can never cross the **boundary** of, once we are in" (G. KAMPIS, 1989, p.89).

A domain delimits the **set** of possible **transformations** for a system. Domains are the results of the establishment of **coordinated constraints**. M. BODEN gives as an example the classical **rules** of harmony in music.

No important work can be done outside the **constraints** of some domain. New domains can be created only by breaking existing **constraints**, and *replacing them with others*, possibly less stringent, or more productive, or simply different.

This implies at least in some measure, that we are mental prisoners within ourselves (and should thus try to take the measure of our inner mental **space**).

The KAMPIS definition is inspired from G. SPENCER-BROWN and F. VARELA, i.e. is related to the concept of **organizational closure**, by virtue of which the system is maintaining its own **organizational invariance**.

KAMPIS comments: "The most important point is that a domain has its **own structure** that cannot be studied directly from another domain (for instance, by an **observer**), it can only be approximated by the internal **structure** of another domain. Of course, different domains might have parallel **evolution** and this enables the formulation of approximate scientific laws that represent, to some extent, what is going on in another domain. However, our original interest is in the things themselves and it is a disappointment (faced by scientists of this century) that they are not available directly" (p.89-90).

This aspect is important for **systemic epistemology**.

0975

DOMAIN in Generic Design Science ¹⁾

J. WARFIELD describes as follows the domain comprised in Generic Design: "A major product of subsumptive scientific studies, which subsumes **components** from various disciplines, as well as **knowledge** not connected to disciplines, and **knowledge** relative to applications" (1991, pers. comm.)

Without any specific one of these **components**, design remains insufficiently founded and its results uncertain.

→ **Quality Control**

0976

DOMAIN of ATTRACTION ^{1) - 2)}

"A **region** in a **state space description** of a system within which the system **behavior** is localized indefinitely unless there is a **change** in system **structure** or a large **exogenous disturbance**" (T.F.H. ALLEN & T.B. STARR, 1982, p.266).

This definition corresponds to a regional and temporary specific **stability cycle** within a more global one.

Domains of attraction have **boundaries (separators)** corresponding to their influence **limits**. They correspond to the **topological concept of basin**.

A **variable** or a system may escape of its domain of attraction as a result of some exceptional **perturbation** which puts an end to its specific **dynamic stability**. This happens through a sudden **discontinuity** or leap (**catastrophe**).

It does not however necessarily imply the destruction of the system, which may have alternative possibilities of **dynamic stability**, within other domains of attraction. If such is the case, the system is said to have **resilience**.

Many ecological, economic and social systems have variable possible domains of attraction and trade some lesser **dynamic stability** for a better capacity of survival through **resilience**, as stated by C. HOLLING (1976, p.81).

0977

DOMAIN of RESIDENCE ²⁾

The **dynamic stability** area in **space** and **time** wherein the **processes** of a system remain constrained.

This concept has been introduced by C.S. HOLLING (1986) in order to specify the **limits** of **resilience** of a system. It closely corresponds to the concept of **domain of attraction** (possibly **Markovian** or even **chaotic**).

At its **boundaries**, the domain of residence also expresses the resistance of a system to contraction under **perturbations** produced by its **environment**.

0978

DOMINANCE ^{1) - 2)}

In an **ecosystem**, the **control** by one species of the basic conditions of existence of other species, members of the system.

In systemic terms, dominance implies the establishment of a **hierarchy** and is characteristic of any **socialization process**.

According to R. FULLER and P. PUTNAM dominance is acquired through a **random search process** "... usually stopped by a sequence or combination of acts" (1967, p.104).

The dominant species controls the **energy flows** and the power **circuits**. For example, birches, oaks or palm trees control the micro-climatic conditions wherever they become the main **element** in the wood, which implies that some species can survive, and others cannot.

Within an animal **group**, dominance tends to instaurate a **hierarchic order** that will diminish the wasteful use of **resources** due to infighting, and increase the global **efficiency** of the **group**.

0979

DOMINANCE (Relative) ²⁾

According to R.W. FULLER and P. PUTNAM: "A relative dominance that takes hold relative to one **random search**, has a logical **feedback**, reshaping all the others. It may be incompatible with some others and upset by the **effect** of some others, so as to produce an alternation... The establishment of relative dominances introduces elements of **order** into the **sets** of mutually exclusive **behavioral elements**" (1967, p.105).

Processes of this kind seem connected with the shaping of **behavioral algorithms**, which thus should reflect the progressive reduction of **randomness** within the **network**.

0980

DOMINANT PROGRAMMING→ **Programming (Dominant).**

0981

DORMANCY¹⁾

The condition of a potential **process** in a system that has not yet been activated by a specific **trigger** factor.

A state of very reduced **activity** of a system, that remains able to be reactivated under certain conditions.

Such a factor is generally a **disturbance** whose origin is in the **environment** of the system. The **activation** of the dormant **process** can however be indirect, or even possibly **endogenous**.

Escaping from dormancy, reactivation can be produced either by some **environmental** impact, or by some internal **agent**. In most cases it seems that the **action** of the internal **agent** is triggered by the environmental impact, as for example in plants and seeds after the dry season or winter.

In **living systems**, dormancy is mainly characterized by a considerable **slow-down** of **metabolism**.

0982

DOUBLE-BIND³⁾ - 4)

A mental, psychological or behavioral tangle produced by an incongruity – apparent or real – between two different **levels** of **contextual** explanation.

The famous self-contradictory **paradox** of EPIMENIDES the Cretan, saying that all Cretans are liars, is a typical example of a double-bind, leading to a logical contradiction.

As noted by R. VALLÉE, double binds are contradictory **constraints**, “generating unstable **behaviors**” and “belonging to **cybernetics of the second order**” (1993, p.95).

Double-binds leave us in a state of mental or psychological confusion and blocks our possibilities of efficient **behavior**.

This important concept, introduced by G. BATESON in 1956 (1973, p.173), has been thus commented by him: “We have learned from the **paradigm** of the freely falling body – and from many similar **paradigms** in many other sciences – to approach scientific problems in a peculiar way: The problems are to be simplified by ignoring – or postponing – consideration of the possibility that the larger **context** may influence the smaller. Our hypothesis runs counter to this **rule**, and is focused precisely upon the determining **relations** between larger and smaller **contexts**” (p.216).

This is a very important systemic and cybernetic notion, because it focuses our attention on the necessity to become conscious not only of the “horizontal” **interconnections** between **elements** or **events**, but also of the “vertical”

ones. Let us altogether take care that “horizontal” or “vertical” are no more than verbal **metaphors** about the supposed **organization** of our mental **processes**.

The subject is closely related to RUSSELL and WHITEHEAD's **theory of types**, from the logical viewpoint and to von FOERSTER's inquiry on **observing systems** (1981).

→ **E. BERNARD-WEIL Agonistics (1988).**

0983

DRIFT¹⁾ - 2)

A succession of **changes** in a system, obeying to no clearly definable **rules**.

Drift generally appears as a **random phenomenon**. This is because it results of various factors, none of them **dominant**, nor necessarily permanent or constant in its **effects**. Continuation of the drift is possible only if and when the occurring **changes** do not modify significantly the **interrelations** of the system or its **elements** with its **environment**, nor its basic internal **organization**.

Drift can be observed in many **phenomena** of very distinct types: in **population** genetics; in business **trends**; in political systems and even in **values** and **norms**.

To the opposite however, M. MARUYAMA states that: “At any one time a **random** initial kick (may) produce a **deviation** into a certain direction. **Deviation-amplification** takes over and this **deviation** is amplified consistently in the same direction. However, this cannot last very long, and soon **deviation** counteracting takes over, and the **population** becomes stabilized with certain characteristics. This **process** then repeats with other **unpredictable** drifts” (1976, p.86-7)

0984

DRIFT (Generic)

→ **Generic drift**

0985

DRIVE FACTOR¹⁾ - 2)

A permanent or recurrent excitation **input** which maintains **activity** in a system.

Such a drive factor reflects either some inherent internal **instability** of the system, or some external energetic **stimulus**. When sufficiently permanent, the drive factor leads to a **nonequilibrium situation** and eventually to **dissipative structuration**.

0986

DRIVER (Fundamental system)¹⁾ - 2)

“A system **variable** at the heart of the driving **mechanism** of the system” (K.E.F. WATT, 1992).

The FSDs are “**variables** (that) override all other systems **variables** in their **dynamic behavior** on the system” (Ibid). They could also be called “basic survival **variables**”.

WATT uses FSDs as a **forecasting** tool, to be applied to what he considers as the **long-term trends** (i.e. covering decades and centuries – as opposed to **extrapolations** from **short-term trends**), most basic for the future of mankind as a **whole**.

WATT considers present or probably imminent global **perturbations**: mass epidemics (AIDS), evolution of **energy** prices, climate **change**, total traffic jam and global pollution. All are obviously probable results of unsustainable exponential **long-term trends**

→ (See also “**Evolutive acceleration**”).

0987

DUALISM³⁾

The theoretical view according to which irreducible **distinctions** can be made between two entities.

The tendency to dualistic thinking is obviously a very basic characteristic of human nature (or possibly of the **brain's** workings).

Systemics is undoubtedly colored by dualism from its very origin, when distinguishing the “system” from its “**environment**”; or “**observer**” and “**observed**”. This bias is however at least partly corrected by the admission of multiple **interrelations** at many **levels** of **complexity**, as for example in **process theory**, in **dissipative structuration** or in **networks**.

→ **Dichotomy**

0988

DUALITY²⁾ - 3)

The twofold **distinction** between opposite aspects in **processes**.

L. CARLSON-SABELLI and H. SABELLI write: “Many systems theories highlight the existence of dualities, often understood as **complementarity**. BOHR's wave-particle **complementarity** is often stressed as a paradigmatic example... **Process theory** recognizes the existence of harmony and **conflict** (the *union of opposites*)... The **union of opposites** implies that it is incorrect to apply two-valued mathematical logic to reality” (1992, p.680).

This means that complementary opposites are not mutually exclusive in a radical way, but generate together a higher **level** of **complexity**.

Avoiding rigid **dichotomy**, J.van GICGH defines duality as “two extremes of a spectrum” (1978, p.590).

0989

DYAD²⁾ - 3)

A **set** of two **elements** or systems which interact in a specific and more or less permanent way.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Dyads are the most basic **structures** of any **complex system**. According to L. CARLSON-SABELLI and H. SABELLI, "The **interaction** of **opposites** creates the third dimension" (1992, p.681). This leads to the **triadic relation**.

0990

DYNAMIC GLOBAL MODEL ²⁾

A complex model including numerous different variable factors and the **interrelations** among them, whose understanding is affected by variable degrees of **uncertainty**.

L. PITEKA et al., referring to Dynamic Global Vegetation Models write: "Because they are global in scope, these models are necessarily coarse in some respects" (1997, p.472).

This explains why the predictive value of these models is always more or less uncertain. Eventual **disaggregation** of such models into submodels does not eliminate uncertainties because it can be done only by suppressing some specific **interrelations**, i.e. a crucial part of the modelled global system.

The authors give very interesting examples of this type of situations.

There is a clear similarity with related problems in FORRESTER's **Systems Dynamics**.

0991

DYNAMIC USE OF MODELS

→ **Models (Dynamic use of)**

0992

DYNAMICS ¹⁾

Classical dynamics was basically **deterministic**, in accordance – with **linear causality**, connecting **variance** of only one cause with the corresponding **variance** of one specific **effect**.

However, as stated by Y. SINAI, it became necessary to understand the conditions and ways by which "... a deterministic dynamics leads to the appearance of statistical laws... Secondly, why are statistical laws *stable*, i.e., why are they not destroyed by small **noises**, **fluctuations**, etc.? It has been believed for a long time that the appearance of statistical laws in **dynamic systems** was unavoidably connected with the increase of the number of **degrees of freedom** allowing for corresponding averages. It is now clear that... in important **classes of dynamic systems** with few **degrees of freedom**, or even only two, a strictly deterministic dynamics leads to the appearance of statistical laws" (1992, p.70).

This understanding led to the study of **ergodicity** and, later on, to research into the onset of **chaos** and **chaotic determinism**. See: "**Chaos (Onset of)**".

From another viewpoint, dynamics does not necessarily implies **continuity**, *at least in models*. Until now, we have no way to decide about dominance of **continuity** or **discontinuity** in the real world.

A.G. BARTO writes: "The term "dynamic" was originally associated only with **continuous-time models** since the differential equation was the only formalism available for **modelling processes** which unfold in **time**. We now know that the idea of dynamics is more general than the differential equation" (1978, p.167).

It is indeed now possible to *spread out automata's* dynamics through **discrete models**, as seen for example in CONWAY's "**games of life**", which are easily modelled on **digital computers**.

0993

DYNAMICS (Chaotic) ¹⁾²⁾

The **dynamics** of any system characterized by its **sensibility** to a set of interacting **initial conditions**.

In fact, chaotic dynamics corresponds to **nonlinear** features in the system.

The **behavior** of such a system cannot be rigorously predicted, even if it remains globally **deterministic**.

This seems to be due to the **anisotropic** and out of **synchrony propagation** of the multiple **interactions** within the system.

→ **Nonlinearity**

0994

DYNAMICS (Non linear) ¹⁾²⁾

Nonlinear dynamics as a field of **models** for **nonlinear processes** and systems include:

- **Bifurcation theory**
- **Chaotic dynamics**
- **Fractals**
- **Neural networks**
- **Power laws**
- **Quantum entanglement**
- **Renormalization**
- **Solitons**
- **Synchronization of chaotic systems**
- **Synergetics**

Nonlinear dynamics is a decisive development in all disciplines when strictly **deterministic** models are insufficient.

It has typically a **transdisciplinarian** character with applications in a broad range of fields from physical to biological and social sciences.

→ **Linear behavior; Linearity; Linearization; Mathematics of nonlinear systems; Nonlinear; Nonlinearity; Randomness; Randomness (Constrained)**

0995

DYNAMO ⁵⁾

"A special **simulation language** applied to **Systems Dynamics**" (J.van GIGCH, 1978, p.330).

This **language**, created by R. SOLOW, has been widely used for **simulations** inspired by J. W. FORRESTER *Industrial and World Dynamics*.

→ **Club of Rome, World models**

E

0996

ECHELON ²⁾

The **organizational level** in M. MESAROVIC et al. taxonomy of hierarchical levels (1970, p.37).

0997

"ECHO" ^{2) - 5)}

"A **simulation** of an **ecosystem** in which **digital organisms** try to survive and reproduce".

This **model** has been created by J.H. HOLLAND.

R. RUTHEN describes it as follows: "All **organisms** are endowed with "chromosomes" that encode offensive and defensive **strategies**. Each **organism** wanders through an artificial **environment**, searching for **resources** and absorbing them into an internal reservoir. If one **organism** encounters another, the two fight, and the winner consumes the loser, acquiring all the **resources** contained in the loser. If an **organism** obtains enough **resources**, it produces offsprings whose chromosomes may contain mutations. New species arise with even more elaborate **strategies** for offense and defense" (1993, p.113).

Initially these **simulations** did not consider **cooperation**. HOLLAND, inspired from R. AXEL-ROD *Prisoners's Dilemma* introduced three modifications:

"First, each **organism** can choose to fight for **resources** or trade for them. Second, each is assigned a tag, which is analogous to a molecular **marker** on the **membrane** of a **cell**. Last, each **organism** is allowed to develop **rules** such as "fight only those **organisms** that carry a red tag". If **strategies** and tags are initially assigned at **random**, some **organisms**, by luck, are more inclined than others to use a **strategy** resembling tit for tat. Those that play such **strategies** are more likely to survive and reproduce, thereby perpetuating the existence of particular tags."

According to HOLLAND: "What started out as a completely **random** juxtaposition of tags and **strategies** begins to develop in a very organized way" and "In the end the **digital ecosystem** displays both speciation and **cooperation** – and such **deviations** as mimicry and lying" (Ibid).

This is again a kind of collective **automaton** in the making and could probably be used to modelize complex economic and social **behavior**.

0998

ECO→ **Contingency (mutual)**

0999

ECO-CUBE/KNOW MAP¹⁾²⁾³⁾

The Eco-cube is a three dimensional **knowledge representation** proposed by H. BENKING.

It was practically realized for the first time in June 1990 at the Exhibition "Global change-Welt im Wandel" that took place at the Bundeskanzler Amt in Bonn, Germany.

It is a kind of upgraded "Rubik's cube of Ecology".

Alike the Rubik cube, the Eco-cube is made of smaller also cubic **elements**

The third dimension is needed "in order to be able to dive into **information**, instead of surfing on the surface, subject to many influences which can distract us".

Benking adds: "We will have to share exploration in order to share common ground. We have to bridge and switch between **models** and **scales**, as one **representation** is not enough, and seeing from various distances, with different focus, lens and filters will help to establish common **references** even in uncharted terrains and vertical realms"

The basic point is "to put different **observations** into a single **context**".

Benking also refers himself to DOXIADIS's **ekistics**. For a complete written and graphic information see: <http://benking.de/Global-Change/spatial-spacial.html>

Benking writes: "We can build **models** like 1x1x1 meter or 20x20x20 meters, where objects in **fields** of (survey) **knowledge**, subject areas or discipline **domains** form one dimension, and in another dimension we have **scales** to see if this field is located in the micro-, meso-, or macrocosm, covering a small or large scale".

→ **Macroscopic; Multiperspectivism; Panorama thinking; cognitive spaces**

1000

ECO-INVASION¹⁾²⁾⁴⁾

The colonization of a new **territory** by a vegetal or animal species.

Hundred of dramatic cases are known on all continents. New ones appear every year. Some of them generate enormous economic **costs**, as for example the South American water hyacinth in Central Africa and in South Asia.

Eco-invasion is perhaps the most significant ecological issue of our time. It started to be an important **phenomenon** at the time of the great geographical discoveries and its main **agent** has been, and still is, man. (See Chr. BRIGHT, 1998)

An invading species is frequently devoid of any natural **parasite** in its new settings. Moreover it benefits in most cases of some advantage as a competitor or predator of older established species. As a result, more than a third of all endangered species of the world are victims of exotic invaders.

From a systemic viewpoint, it is a result of massive development and acceleration of world **communications**, which are connecting in an evermore efficient way **biotopes** which were formerly isolated from each others.

The model could be of interest in **social sciences**.

1001

ECOLOGICAL RELEASE⁵⁾

A sharp decrease in competitiveness in an **environment** where numerous individuals or species have been suddenly eliminated through some catastrophic **event**.

In such cases, the rare survivors have an exceptional chance to massively increase their stature and/or their numbers. This **phenomenon** can be observed in a forest clearance or on recently cooled lava flows.

It has been conjectured that the massive evolutive radiation of big dinosaurs was caused by such an event. It was also possibly the case of the sudden success of mammals after the seemingly catastrophic demise of the dinosaurs.

It would be interesting to see if an analogous **effect** takes place after catastrophic social upheavals (as for example **pandemics**, destructive wars or great economic crashes).

1002

ECOLOGICAL SUCCESSION⁵⁾

The **process** of progressive reestablishment of an **ecosystem** after a strong **perturbation**. (E.P. ODUM, 1997).

The reorganized **ecosystem** may be, for some time or definitively, different from the original one, depending on steady or changing **environmental** conditions.

The succession is predictable within limits. It can be deeply affected by **human action**. For ex. cultivated land can replace forest in a definitive way and complete reversal may never anymore be possible.

1003

ECOLOGICAL TRAP^{1) - 2) - 4)}

Any **situation** in which a **population** perturbs its **environment** to the point of being unable to survive.

G. VICKERS, who introduced the expression, explains it as follows: "A **population** in a favourable but unfilled **habitat** normally multiplies at a constant **rate** until it meets or breeds limitations which slow and in **time** arrest its **growth**. It may then stabilize, at or below its

maximum, in the same or an altered form, with **oscillations** of less or greater **amplitude**; or it may even disappear, because in its period of expansion it has either **unfitted** itself for life in a limited **environment** or **unfitted** its **environment** to support even a limited **population**" (1967, p.61).

This is a much more subtle and adequate formulation of the old Malthusian principle. There is probably nothing more important for mankind in all system science than this nugget of ecological wisdom.

→ **Overcrowding; Undercrowding**

1004

ECOLOGY¹⁾

The science of **interactions** of **living systems** among themselves and with their **environment**.

Already in 1866, E. HAECKEL defined ecology as the global science of the **organisms** relations with their surrounding world, in which he included generally all the conditions of their existence.

Later on, scientists like A. LOTKA (1924, 1956) and V. VOLTERRA (1931) studied more restricted **phenomena** as, for example the **interrelations** of two or three species. Others considered mainly lesser biotopes: a meadow, a small island, a wood.

However, more recently, HAECKEL's programme has been retrieved as it becomes ever more obvious that these restricted inquiries should be put into the perspective of a much more global **understanding**.

The French ecologist F. RAMADE writes: "Ecology studies **complex systems**; its approach is thus, ipso facto, of a **holistic** nature. Its object is at the summit of the organizational ladder of **living systems**: The simplest biological entity of its concern is the **population**. Furthermore and by order of growing **complexity**, its objects of study are **colonies**, living **communities**, **ecosystems** and **biosphere** as a **whole**" (1993, p.424).

Ecology is thus a typically systemic science.

1005

ECOLOGY (Computational)⁵⁾

The computer **modeling** of **emergent** and **autopoietic** properties in **networks** of interacting **artefacts**.

S. GOONATILAKE states: "As **Artificial Intelligence** devices and **communication** devices become increasingly interconnected, **patterns** of **information** classification and of **information processing** are allowed to form spontaneously from unplanned **interactions** that arise from within the system itself. In doing so, these devices enter into the realm of **autopoietic**

processes". Furthermore "Some of the evolutionary characteristics revealed in these systems are reminiscent of **punctuated equilibrium** in biology" (1991, p.163-4).

The **emergence** of **autopoietic** properties was first modeled by F. VARELA, H. MATURANA and R. URIBE (1974) and developed by M. ZELNY and N.A. PIERRE (1976).

The subject is closely related to **connectionism** and **connection machines**.

1006

ECOLOGY OF ACTION

→ Action (Ecology of)

1007

ECOLOGY of IDEAS³⁾

G. VICKERS stressed: "... the need to develop concepts of **stability** applicable to appreciative systems" considering that: "All **communication** – and hence **cooperation** – depends on (such) *shared*... systems, on ways of conceptualizing and valuing which are systematically organized and which, when they change, may have to change extensively before they reach anything approaching a new **equilibrium**" (1970, p.182).

Of course, ideas are carried by people and appreciative systems are a *collective* tool, obtained by *consensus* (always *provisional*) and selectively transmitted by people through time. (KORZYBSKI's *time-binding*).

1008

ECOLOGY of KNOWLEDGE^{1) - 3)}

"The study of **patterns** of **interrelationships** among the various "species" (**subsystems**, sub-subsystems, etc.) and **fields** and subfields of **knowledge** with emphasis on:

a) preserving the condition of dynamic balance between the "species" and their **environment**; and b) **optimizing** the overall **sybiotic** fruits of **synergistic interactions** among them" (J.W. CLARK, 1972, p.168)

CLARK proposed a curriculum in "General ecology of **knowledge**" divided as follows in five sections, including among other subjects:

A. Systems Education Studies

Systems approaches;... **simulation**;... systems **management**;... **game theory**;... **forecasting** methods and **operations research**.

B. Basic Integrated Studies

General **cybernetics**;... eco-cybernetics;... meta- tools;... meta-skills;... **metalan- guages**;... general ecology of **knowledge**

C. Global Design Heuristics

Heuristic forecasting;... **synergetics**;... synergetics;... **pattern recognition**...

D. Heuristic Meta-Policy Studies

The anatomy of meta-policy;... the anatomy of **change**;... Psychology of mass movements;... systems of **signals** and incentives;... **games** for global involvement;... the **dynamics** of **feedback** and **reinforcement**...

E. Meta-Policy Sciences

Behavioral sciences and general systems perspectives;... designing and evaluating alternative futures;... integrative workshops

For the discussed complete program, see reference (p.165-180).

This proposal, made in 1972, does not seem to have been seriously debated and, still less, applied anywhere. The institution of *interfaculties* **programs** of this type would possibly be the only way to seriously expand the **systemic approach** and **methods**.

1009

ECOLOGY of MIND³⁾

This expression has been coined by G. BATESON, who admitted that: "Perhaps '**epistemology**' is only another word for the study of the ecology of mind" (1973, p.372).

It could however something more specific, as there are no two identical "minds" (i.e. **brain network organization**), while **epistemology** pretends to establish general **rules** for **validation** of **knowledge**.

1010

ECOLOGY (Somatic)

→ Somatic Ecology

1011

ECO-MATRIX²⁾

An **input-output matrix** used to represent in a tabular form all the possible **interconnexions** within an **ecosystem**.

A non-existent **interconnexion** is represented in the matrix by 0 in the corresponding intersection.

The matrix is an alternate **representation** of the corresponding **network diagram** and its use has been proposed by H. ODUM. This author gives as an example a matrix of the **steady state flows** of carbon in a microcosm grouping CO₂, its organic **storage** and its living producers and users.

This form of **representation** allows for "... the use of techniques of matrix algebra by systems analysts" (1971, p.20-21).

1012

ECONOMICS in systemic terms^{1) - 4)}

Elaboration of economic theory and practice in systemic terms is still largely a pending subject, in spite of the relentless efforts of K. BOULDING, one of the three founders of the I.S.S.S. (1952, 1968, 1972 and 1978).

J. WARFIELD observes: "The failure of economics schools of thought to provide an adequate basis for governmental policy is directly related to the **complexity** of the subject and the absence, within economics, of any **strategy** for dealing with that **complexity**". He also denounces the unwarranted simplifications in economics **models** of human **behavior**: "... it is clear that the postulated human being found in economics theory has little in common with most human beings" (1990a, p.66-7).

Such criticism is aimed at capitalist as well as at marxist economics.

M. MARUYAMA, in turn, observes that economic theories – and their practical prescriptions – depend on the **mindscapes** of their respective authors.

An **Homogeneist-type** formulation "assumes that the **cause-effect relationship** goes from the **key variable** to other **variables**. **Causal loops** are either ignored or paid lip service" (1994, p.9). Such minds select "*the cause*", "such as the social security system, the credit card system and even the education system". For an **Heterogeneist randomizing mind** "If everybody... is self-sufficient, there is no economic problem (grow your own potatoes). Economic **interactions** among people are the cause of the problems. For the Heterogeneist cooperative mind, "the economic system is inherently **self-stabilizing** or **cyclic**. **Disturbances** are due to "**exogenous**" (non economic) influences, such as interferences by government and wars. "Laissez-faire is the best policy". And for the **Heterogeneistic cogenerative mind**, the economic system contains both **change-amplifying** and **change-counteracting loops**. Economic policy failures occur when **change-amplifying causal loops** are ignored" (p.9).

This last view is MARUYAMA's preferred attitude. While this "landscape of **mindscapes**" could be controverted, it emphasizes at least the generally ignored cultural and psychological roots of economic theories.

Historically, the impact of the economic activities of small, or even medium human **groups** on global **environment** was slight and could be ignored (even if some archaic and historic cultures were probably self-ruined by their own **environmental** abuse).

It is however not anymore possible to understand in a realistic way economic **processes** without settling them firmly on the base of **energy flows**, considered from a **thermodynamic** viewpoint.

This has been done by N. GEORGESCU-ROE-GEN (1971 and 1982); by H.T. ODUM (1971, 1976, 1991); by R.N. ADAMS (1975 and 1988), and more recently by J.R. PROOPS (1983, 1985, 1987) among others.

It is also impossible to support sound economics without taking in account another consequence of **thermodynamics**, i.e. the massive production of difficultly recyclable **waste** by producers and consumers and the resulting relentless **growth** of an enormous **ecological problem**. This subject has been widely studied, again by H.T. ODUM and, more recently by many others.

Other authors have considered the improper use and squandering of energetic and material **resources**, f. ex. D. PIMENTEL in agriculture (1977) and E. MISHAN, in relation to economic **growth** (1969 and 1987).

More recently, the subject of so-called "**sustainable development**" has been considered, while generally in a non-systemic way.

Unfortunately, the main currents in economic theory remain still unaware or indifferent to these insights.

Quoting H. DALY, CHANG-GEN BAHG defines the following basic systemic views about economics: "First, from the physical point of view, the economic **process** is an **entropic process**; Second, wealth is a kind of **open system** because it is produced in the **throughput process** which begins with depleting **matter-energy** of low **entropy** and terminates with extruding **matter-energy** of high **entropy**, in equal quantity in the **environment**; Third, the mechanical **phenomenon** is reversible (note from the compiler: this is arguable !), but the **entropic phenomenon** is **irreversible**...; Fourth, there is an **anti-symmetric** relation between two **sources** of low **entropy**, that is, on one hand, the total quantity of **energy** bearing low **entropy** of the sun is infinite (this again, is arguable, at least in principle!), but its **flow rate** toward the earth surface is finite. On the other hand, the total quantity of substance of low **entropy** on the earth, such as the ore condensed in crust, is finite, and these substances are doomed to exhaustion" (1990, p.93).

One more basic fact is that, as a planet, earth is a limited **sink** for useless non-**recyclable waste**, including most specially degraded **energy** (i.e. heat). This **problem** is now reflected in the possibility of a warming of the climates at global **scale**.

From another viewpoint, the reduction of human motivations to merely quantitative satisfaction of material needs suppresses the systemic aspects of the psycho-social and socio-cultural of human **behavior** and the **dynamics** – possibly emergent and/or chaotic – proper to the **evolution of human systems** as complex as empires, nation-states and even international business enterprises, whose **management** cannot be reduced merely to sales, profits, balance sheets, **input-output matrixes**, marketings, and the like.

In synthesis, the construction of a new economics in systemic terms (**ecological, thermodynamical, psychosocial, sociocultural, etc...**) is an urgent need.

A most important subject in this sense is **recycling**, which corresponds to the shaping of a more or less closed **cycle** economy, where only direct or indirect solar **energy inputs** would dynamize the **man-planet system**. In this way, the most sustainable economic **activity** would be secured with a lesser global production of **entropy**.

1013

ECOSPHERE^{1) - 2)}

The global physical, chemical and biological planetary interactive system.

The ecosphere is now increasingly dominated by the **activities** of the human species, whose influence is globally disturbing it, through the excessive use of non-renewable **resources** and general abuse of its use as global **sink** for evermore numerous non-recyclable products.

1014

ECOSYSTEM^{1) - 2)}

A **community** of interconnected and interacting systems, depending of specific **energy inputs** and evolving as a **whole**.

The original definition as introduced by the british plant ecologist A.G. TANSLEY, was: "A community of **organisms** and their physical **environment** interacting as an ecological unit"(as quoted by F. CAPRA, 1997, p. 33)

R. MARGALEF describes the ecosystem most generally "... as the material **path** followed by **energy** that generally enters in the form of photons and goes out into an **energy sink**" (1968, p.14). In the mean-time, **energy flow** may construct less or more complex ecosystems, with however a tendency to maximize **complexity**. The more organized **parts** tend to have a selective advantage on the less organized ones, due to their better possibility to use and increase their **information**. According to MARGALEF: "This is an extraordinarily valuable principle not only in ecology but also in the **general theory of systems**" (p.28). See "**St. Matthew Principle**".

H. ODUM, in turn, describes the ecosystem as: "... a **network** of food and mineral **flows** in which the major pathways are **populations** of animals, plants and microorganisms, each specialized to live in a different way, doing a different job for the **energy flows** of the system" (1971, p.60).

He adds: "... the purpose of having many species is ... the increased system **effectiveness** possible with specialization, division of labor, and more kinds of **controls** and **regulatory circuits**"(Ibid). A. LOTKA "**world engine**" **model** is a closely related formulation of the same global concept (1956, p.334).

ODUM's **effectiveness** is somehow related to ecosystems tendency toward global stabilized **complexity (climax)** at the highest **level** of **energy flows** use. Such a closely limited **dynamic equilibrium** means that they are stabilized by countervailing **feedbacks**. However stabilized ecosystems seem to lose **resilience**, unless they are submitted to periodical **environmental disturbances**. Their very **complexity** helps them and simultaneously hinders them in this **process**. S. REICE contends that: "...**equilibrium** is an unusual **state** for natural **ecosystems**", and that "... the normal **state** of **communities** and ecosystems is to be recovering from the last **disturbance**" (1994, p.427).

This is coherent with St. KAUFFMAN's hypothesis according to which "Ecosystems **co-evolve** to the edge of **chaos**" (1993, p.261).

Living systems are particularly significant in many ecosystems, because they modified and go on modifying the **interactions** between the lithosphere, the hydrosphere and the atmosphere.

The planet is our global ecosystem (see **Gaia hypothesis**) and it is basically fuelled by the sun's **energy**, which has been and still is the prime mover of its **evolution**.

Ecosystems are in some sense **hierarchized** (but not truly **hierarchical**, as there are no specific **regulators** or **controllers**, with the dubious exception of man himself, a disturber more than a **regulator**), i.e. simultaneously organized from more global to more local and specific ones "**top down**", but also conversely from the base **levels** to the upper ones. This explains that a vast ecosystem can be deeply transformed by the intrusion or elimination of some apparently unimportant **class** of **elements**.

Some specific smaller ecosystems can be more or less isolated within more global ones, at different **levels**, as for example: the "tropical rain forest", some specific tropical rain forest, some small specific **patch** of the same, or even, **part** of the canopy corresponding to this **patch** or the bark of one specific tree. Of course, the **environment** should never be totally forgotten.

G. BATESON, as well as many other authors, emphasizes that: "We are rapidly, of course, destroying all the natural systems in the world, the balanced natural systems. We simply make them unbalanced – but still natural" (1973, p.406).

We should never forget that any **change** of one **part** necessarily implies and triggers **changes** – frequently **unpredictable** – in the other **components**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The introduction of **chaotic models** seems to be an urgent need in ecosystemics.

1015

ECOSYSTEMIC RELATION ^{1) - 2)}

E. MORIN enunciated the following double principle about the **interrelation** between a system and an **ecosystem** which supports it: "The system responds by way of its own **determinism** to the **randomness** of the **ecosystem** while it responds in an **aleatory** way to the **determinism** of the ecosystem".

MORIN explains this apparent contradiction in the following terms:

"1. The system opposes its **determinism** to the **randomness** in the **ecosystem**."

"The **self-organizing system** creates his own **zone of determinism**: the difference between a similar agglomeration of **cells** when living or dead is that while the first one conforms an **organism**, a system obeying its own **determinism**, the other one obeys the physico-chemical **determinism** of the surroundings."

"The **living systems** fight by multiple **means** the destructiveness immanent in the surroundings... they tend to reduce the external variations... (and) to impose their law, against external adverse conditions."

"a) The system tends to dampen variations of the external **medium** and imposes within itself its own **constancies**: this is **homeostasis**... The **negative feedback** is the well known **regulator** which contrasts the **random perturbation** and re-establish the **homeostatic state** wherever it has been affected."

"The "system produces a non-**random response** to a **random event**, at the very place of the **circuit** where the **random event** took place" (as quoted from G. BATESON, 1967)."

"b) The system tends to impose its own **determinism** on the **environment** in spite of adverse conditions. This is **equifinality**, by which a finalized **state** of the system can be reached, starting from different **initial conditions** and by different ways."

"2. The system opposes a **random variability** to the **environmental determinism**."

This is already the reverse of the former proposition, in view that a system able to create a **zone** of proper finality (in its **vicinity**) escapes in this way from some **effects** of the external **determinism**" (1972, p.180).

Thus the system obviates many unfavorable **environmental perturbations**, while becoming capable to produce **effects** in its **environment**.

P. VENDRYES had already expressed similar ideas in his 1942 book "Vie et Probabilité".

1016

ECOSYSTEMS DYNAMICS ^{1) - 2)}

According to B.C. PATTEN, as quoted by A. CASELLES MONCHO and J.L. USO DOMENECH "...ecosystems dynamics in non perturbed **states** is approximatively **linear**, although its internal **processes** were **nonlinear**" (1993, p.438).

"Non perturbed" should be understood as "not much perturbed", i.e. perturbed in a limited **stable range**. This is the case of mature ecosystems (formerly described as **climax**).

Moreover: "Biotic **components** of an ecosystem have limited **resources**". This explains why **stable** ecosystems, when seriously perturbed, may **irreversibly collapse** (The case for example of overexploited tropical rain forests, or overfished oceanic areas).

And: "Non perturbed **dynamics** is produced in a bounded **range of operations**... and: **Operations** occur in a bounded **range of values**" (Ibid).

This aspect has been tackled in a different way by W.R. ASHBY, who describes "equilibrium densities" and "terminal **equilibrium**" and uses **MARKOV chains** and **Markovian matrices** to modelize such **equilibria** (1956, p.177).

Ecosystems can also undergo strong **perturbations**, which may put an end to their **homeostasis**. One case is the appearance of a mutant **population** that deeply affects the global **equilibrium** of the system. In such a case it will self-reorganize in a new way, probably at a higher **level of organization**.

Another case is the destruction of an important **component**. This may lead to a crash, i.e. to a globally lower **level of organization**. In many cases the **introduction** of an alien **component** may bring such a havoc: For example goats or rats and cats on formerly isolated ecosystems.

1017

ECOTONE ⁵⁾

The blurred **transition zone** between an **ecosystem** and its **environment**.

In this **zone**, **parts** or **elements** of the **ecosystem** can be affected by **edge effects**, as they must adapt to **disturbances** or different conditions originated through local (and sometimes **fractal**) inroads of their **environment**.

The **effect** is frequently observed in burned down **patches** in a forest, or at the **edge** of a mangrove, or close to the **boundary** of forest and cultivated land.

The ecotone model could possibly be extended to sociology, in relation to cultural or social exchange, or mutations near **boundaries**.

1018

ECTROPY ^{1) - 2)}

"...the ability of **open** and organized **systems** to use the **environmental** substances, rich in easily released **energy**, to maintain... a given **level of entropy** or even to lower it" (V.I. KREMYANSKIY, 1969, p.142).

Systems do this as they "maintain irregular **distributions (gradients)** of substance concentration and support synthesis **processes** founded on the binding and simultaneously the dispersing of **energy**" (Ibid).

The concept was imagined by AUERBACH, according to whom "...life is an **organization** created to avert the menacing **entropy-death** of the universe" (L.von BERTALANFFY, 1969, p.77).

BERTALANFFY states: "Ectropy does not exist. However, **thermodynamics** was concerned only with **closed systems**, and its extension to **open systems** leads to very unexpected results" (Ibid).

Originally the notion of ectropy was no more than a purely verbal explanation, in finalistic terms, of a still quite ill understood **situation**, i.e. the existence of some compensation to the **entropic** degradation of **energy**. More recently, PRIGOGINE and his school developed the new **thermodynamics of open systems** and extended it to the **irreversible systems** with structuring **dissipation of energy** and eventual **emergence** into higher **levels of complexity**.

However, in his 1960 paper, KREMYANSKIY was already giving a satisfactory **meaning** to the concept of ectropy.

1019

ECUMENOPOLIS ⁴⁾

The coming planetary global human system with its corresponding ecological **environment**.

The term has been introduced by C.A. DOXIA-DIS, the founder of **ekistics**

→ **Ecological model of the man-planet system**

1020

EDGE EFFECT ^{2/5)}

The modifications in the **parts** of the system close to its **boundary** resulting from influences of its nearby **environment**.

This concept relativizes somewhat the one of **boundary**, specially in **ecosystems** wherein no **boundary** can be neatly established. In **ecology**, the edge of an **ecosystem** is also called "**ecotone**".

The effect has been observed, for ex. in isolated forest **patches** in Amazonia after the clearing of their **environment**.

B. HOLMES writes: "For the first few years, the forest floor is warmer and drier for at least 60 meters in from the edge... This burst of light and higher temperature has a profound effect

on the tree seedlings that dot the forest floor. A lot of these small seedlings will die off, and others that are adapted to drier conditions will take over" (1996, p.36).

However, when the cleared **environment** returns to more bushy conditions, this edge effect decreases and finally disappears.

Edge effects seem probable in any system composed of a **variety of elements** whose **behavior** may respond in different ways to a **variety** of conditions and become submitted to the influence of a transformed **environment**.

Edge effects may lead to "ecology-driven speciation" (J. ENDLER, as quoted by K. BROWN, 1999, p.48)

They are probably present in human systems where these conditions sometimes happen.

→ **Herd effects**

1021

EDUCATION ^{1) - 4)}

The **process** of acquiring or transmitting the condition of becoming and being a biologically, psychologically, mentally and socially well integrated person.

What must be obtained through education is an adaptive set of **values, norms** and **habits** tending toward the avoidance of dangerously incoherent or conflictive **situations** at any **level** (in J.G. MILLER's sense of the systemic **levels of complexity**, from **organism** on) or, when unavoidable, be able to make the necessary **adjustments** in the best possible way.

Education is at the same time a personal and a societal responsibility. It supposes a progressive training at the different **levels** of the nervous system, and particularly, the different **brain levels**. As adaptive **change** is becoming ever more necessary for the individual and in **social systems**, the historic rigidity in **values, norms** and **habits** is becoming inadequate. Education should now include the **understanding** of **change** in natural and human **environments** and the conditions and ways of obtaining a better **fit** when needed.

It should thus tend to adaptive and permanent **autonomous self-regulation** through the frequent critical review of one's **frames of reference**.

1022

EDUCATION (Dimensions of systemic): The technical and organizational angle ⁴⁾

B. BANATHY proposes a three-dimensional structuring for systemic education, in order to take in account the whole complex setting of the educational **situation**. He writes: "The usefulness of a three-dimensional structuring (**content**, target groups, **context**) can be seen

when we consider the analysis **design, development**, implementation, and **evaluation** of systems education in terms of such enquiries as what kind of systems education is best suited for what kind of people and in what kind of **contexts**" (1993, p.287).

BANATHY's views make it readily evident that no really useful educational scheme can be reduced to **methods**, or material **means** only. Nor is it positive to consider education and **knowledge** transference separately. It is also obvious that systemic education should be co-participative, i.e. developed in common by the whole **community**, including the educandi themselves.

Concurrently, as observed by R. RODRIGUEZ DELGADO: "Design of educational systems should take into account not only systems specialized in education – schools, universities, research centers, etc. – but also the whole society. The family, the working place, the political institutions, the labor unions, the churches, the sports installations, the **communications networks** – telephone, radio, television, video, internet – are sources of constant **learning**, that frequently are noxious. A new educational system should try to influence the redesigning of these **learning sites**" (1990, pers.comm.).

Besides: "From the viewpoint of global societal **learning** it would be advisable to explore questions like the following:

"How to devise **methods** for quick **adaptation** of the school to **changes** in societal needs or desires.

"How to redesign schools and school systems in order to use **communications, informations**, video, compact discs, and other technologies for global societal **learning**.

"How to redesign the school to implement, among other things, the **functions** of an **information** center, serving not only the school, but also the **community**.

"How to redesign schools and school systems in order that they could contribute to integrated **community development**.

"How to make available to the learners free space – or computer software – in order to design new types of school in accordance with their wishes.

"How could design contribute to increase innovation and **creativity** among leaders" (ibid).

Let us however remember that all technological **means** are *neutral*, i.e. can be used for **any purpose**. The previous definition of the **purposes** is thus paramount.

Let us also remember that neither innovation, **creativity** nor wishes are necessarily bountiful, if a good **understanding** of natural, social and personal conditions and **situations** is not created, to begin with. (see hereafter).

1023

EDUCATION (Systemic) ^{1) - 4)}

A way to transmit, by an appropriate training, an integrated **understanding** of oneself and of one's **interrelations** with nature as a whole as well as with other people, eventually of different cultures, races, creeds and **languages**.

Nowadays, there is much talk about "education", but it is generally confused with "instruction", i.e. **knowledge transmission**, or training, which is now not much more than the acquisition of a specialized trade or **knowledge**. Instruction has slowly pushed education out of the classrooms and auditoria.

The school does not anymore bother much about religious belief, philosophy, **ethics** and civics. As to the practical art of living, i.e. how to live in peace with oneself, how to be a good husband or wife, a good father, mother or son, how to avoid the traps of modern life (racism, ideological fanaticism or stupidity, drug addictions, crime as an author or as a victim), how to respect nature's **equilibria**. All these do not now seem to be anybody's matter, at a time when the churches themselves become confused and the media seem to believe that ratings depend on blood, violence, cheap or degraded sex, terror and so-called sport (2, 10, or 22 players, *for money*, and 50.000 well named nerve-racked "fans").

Of course, our new problems, as for example our local and global relation with our **environment**, the impact on society of new technologies, the planetarization of many **situations**, are totally ignored by what we still dare to call "education".

And who has ever heard of training the common citizen to give him/her some **understanding** of politics, that most important social activity in order to allow him/her to distinguish clearly, and properly evaluate the rabble-rousers, the corrupts, the fanatics, the lightweights, the cynics, or simply the dangerously incompetents; and to teach her/him how to be a participative and responsible citizen, who does not believe in fairy tales.

In synthesis, older education does practically not exist anymore, and none adapted to the **complexity** of our present world did yet emerge, which is one of the main reasons why the fabric of societies is torn into shreds in so many places.

A **systemic-cybernetic approach** to environmental, societal and personal problems would help to recreate a suitable educative **frame**, basically by maintaining the natural **systemic-cybernetic** attitude of newborn, infants and children, who learn by **trial and error** (a **cybernetic process** based on **feedbacks**) and by slowly disintricating internal and external **complexity**: toddlers are the most accomplished systemists, which is why they survive.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Systemic **learning** and/or training should of course be adapted according to age and culture.

R. RODRIGUEZ DELGADO proposes the following general systemic approach to manage this situation:

"The **design** of educational systems for a complex world cannot be based in pre-established rigid formulas. However, some wide scope principles, like the following, could be generally accepted.

"a) Lack of dogmatism. Closed cultures tend to reject all other **ideologies**, showing themselves as the ultimate truth. Systems thinking, on the contrary, should be open. Criticism of the **systems approach** should be stimulated. **System theory** should be liberated of any shackles, as FLOOD advises (1989).

"b) **Design flexibility** should be maximized. **Design** should be adapted to cultural varieties; increase participation; allow for a global conception in which similarities, **differences** and **conflicts** could be studied; represent a planetary vision vs. chauvinistic thinking.

"c) **Design** should take into account the **complexity** of systems, conceiving their **elements** as pervasive and their **limits** as **fuzzy**.

"d) Integrated **design** of educational systems is important. But it is convenient to see that there are many possibilities of **synthesis** and **integration** and that some of them are preferable to others.

"e) Experimentation is vital in designing educational systems. A **design** that appears intellectually flawless could fail totally when implemented. Failures, however, are ways of learning to make better **designs**"

Moreover:

"In our complex world, education should cover all the main fields of human thinking and acting. Philosophy, Natural and Human Sciences, Arts, Axiology, Methodology, Technology, Manual skills, Physical fitness and Ludic activities. The different fields should be conceived as parts of a **network structure** that envelops human existence" (pers. comm.)

As a result, it could be said that systemic education cannot be taught. It must be learned and practiced in **community** by all **stakeholders**.

1024

EFFECT (Critical)

→ Critical effect

1025

EFFECT (Delayed) ^{1) - 2)}

An effect that becomes apparent only after a very long **time**.

The existence of delayed effects is generally well perceived ("The last straw that broke the camel's back"), but nonetheless nearly always unperceived and unpredicted... and when predicted, mostly met with wide skepticism.

These effects tend to be **catastrophic**, for the following reasons:

- They generally result of a slow **accumulation** of very small and scantily visible effects at a **time scale** so long that it escapes the common **observer's** attention;
- They generally result in violent and very sudden **discontinuities** ("**catastrophes**");
- Their mostly show up at a **macro- or mega-level** in **time** and frequently catch their victims in a state of total unpreparedness, because they are so difficult to **forecast**.
- This **unpredictability** is compounded by the fact that they frequently lead to global **instability** and **chaotic behavior**.

Delayed effects are universal in **complex systems**:

- In physical systems: Earthquakes, floods, great forest fires, volcanic eruptions:
- In **living systems**: epidemics, strokes, infarcts
- In economic systems: bankruptcies, market crashes
- In social systems: civil wars, revolutions

Delayed effects seem to be closely related to **phase transitions**, **giant fluctuations** and **chaos**. They frequently lead to **irreversible changes**.

The most dangerous delayed effects are the most delayed ones, generally related to not very obvious **mega-trends**. The closer study of delayed effects could lead to a "science of potential dangers" and better **risks evaluations**.

→ **Cyndinics**

1026

EFFECT (Position)

→ **Positional value**

1027

EFFECTIVENESS ¹⁾

The production at the least possible **cost**, by a **process** or **behavior**, of the expected or desired result.

To maintain effectiveness, it may be necessary to modify the **process** or **behavior**. Effectiveness is thus at a higher **level of control** or **management** than **efficiency**.

1028

EFFECTOR ²⁾

The device through which a system becomes able to act on its **environment**. (Sometimes called "actuator" - J. MILSUM, 1968, p.41)

The effector is the last link indispensable for the working of the **regulator**. It must be able to receive and interpret or understand the **messages** sent by the **adjustor** and to translate them to specific corrective action (A. LOTKA, 1956).

P. VENDRYES has shown that, to be able to operate, an effector must have sufficient qualitative and quantitative **reserves** (usable internal **resources**) at its disposal (1942).

1029

EFFECTS (Herd)

→ **Herd effects**

1030

EFFECTS (Law of) ²⁾

Other things being equal, **connections** grow stronger if they issue in satisfying states of affairs" (As adapted by E.von GLASERSFELD, 1988, p.224)

This law was enounced by E. L. THORNDIKE in 1911 and was very influential in behavioral psychology, as well as PAVLOV's conditioning, with which it can be compared.

The law is akin to the **Hebb's rule**, which is however less radical, and at the same time more precise.

THORNDIKE himself explained his law as follows: "Of several **responses** made to the same **situation**, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the **situation**, so that, when it recurs, they will be more likely to recur: those which are accompanied or closely followed by discomfort... will, other things being equal, have their **connections** with that situation weakened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond"

Thorndike duly acknowledges that "... the phrases "result in satisfaction" and "result in discomfort", need further definition, and the "other things" that are to be "equal" need comment...

"By a satisfying state of affairs is meant one which the animal does nothing to avoid, often doing things to attain and preserve it. By a discomforting or annoying state of affairs is meant one which the animal commonly avoids or abandons".

An important comment of THORNDIKE is that: "The satisfying and annoying are not synonymous with favorable or unfavorable to the life of either the animal or the species. Many animals are satisfied by deleterious conditions. Excitement, overeating, and alcoholic intoxication are, for instance, three very common and very potent satisfiers of man".

On the other hand: "Conditions useful to the life of the species in moderation are often satisfying far beyond their useful point; many conditions of great utility to the life of the species do not satisfy and may even annoy its members" (1911, chapter 6).

Moreover, THORNDIKE hypothesized that all these effects were results of neuronal activity at the **synaptic level**. This is impressive as one remembers that his work on these topics was published in 1911, not so long after the basic discoveries of RAMON y CAJAL (1852-1934).

1031

EFFECTS (MASS)^{1) - 2) - 4)}

The compounded **processes** or **phenomena** which appear only by **accumulation** of numerous individual **actions** or effects in a limited **space** or **time**.

Mass effects are characterized by the growing **density** of **relationships** between **elements** and/or **groups** of **elements**. They appear (sometimes quite suddenly) when a upper **density threshold** is crossed. They are generally unpredicted and even not understood, nor taken into account until they become a considerable source of trouble.

As stated by the French sociologist R. BOUDON, mass effects are generally "perverse" in the sense that the mass **process** brought about by **overcrowding**, leads to **overburdening** or **overload** and hinders or impedes individual **actions**. Urban traffic congestion is a good example.

1032

EFFECTS (Side)¹⁾

Unplanned results of a planned **change** in a **process** or system.

(also known as "spillover effects" (J.van GIGCH, 1978, p. 153).

Side effects are a typical result of non-systemic misunderstanding of complex issues.

They are a frequent result of **planning** based on **linear** methods, without regard to **complexity** in **processes**. Side effects are nearly always unexpected and suppressive, because they generally emerge outside of the scope of the **development** considered. They become more and more frequent with the ever wide-embracing nature of man's interventions in natural **processes**. While they are not necessarily negative, they should be as much as possible preventively monitored.

Moreover, in fact many side effects could be considered "wicked" (the french "effets pervers" of the sociologist Raymond BOUDON), because they frequently derive from apparently positive steps taken to solve or alleviate serious problems.

Some recent examples are: newly acquired resistance of pathological agents to antibiotics and of pests to pesticides; massive and unmanaged rural emigration caused by the green revolution; disastrous spills resulting of massive oceanic transportation of oil; social and urban transformations due to massive use of cars. The key word is "massive"! Many more cases could be cited and still more are undoubtedly in the making.

Such counter-intuitive **messes** are results of a partial and out of **space** and **time** context approach to the addressed **issues**

The systemic study of the complex **interactions** of any system with its **environment** – as a complex **whole** itself – should be very helpful to **forecast** and prevent such **situations**.

Side effects have enormous ethical bearings, fully described by J.van GIGCH (Ibid).

1033

EFFICACY (Self-)²⁾

A **self-referent process** that gives **meaning** and **value** to external **events**"

This definition by A. BANDURA is quoted by R. NUMMELA CAINE and M. CAINE (1994, p.80)

The **concept** is clearly related to the basic notions of **autopoiesis**.

It also reminds of J.J. GIBSON's concept of **affordance** (1966, 1986).

Creating self-efficacy in learners and trainees is surely as important as transmitting them **knowledge** or **skills**.

1034

EFFICIENCY^{1) - 2)}

"The relationship between **energy** (or material) **input** and **output** in a particular **reaction** of transaction" (H.S. FOREST, 1994, p.203).

This very general definition also applies to systemic **processes** and **outputs**.

Efficiency can be evaluated as the probability or **rate** at which a specified **output** is produced in specified conditions by some **process** applied to a specific **input**.

Efficiency **evaluation** implies some **criterion** about the **relevance** of the proposed course of **action** to the existing **situation** and, if the **action** is to be repeated, of the **stability** of the conditions observed.

Good examples are the frequently conflicting **evaluation** of efficiency in developmental projects, as for instance the uses of wetlands.

Effectiveness implies an **observer** and **actor's** viewpoint, and more specifically, presupposes efficiency.

1035

EFFICIENCY (Limits to)^{2) - 4)}

Efficiency is a somewhat questionable concept. If applied to systems functionality, it is possible to distinguish at least three different shades of **meaning**:

- Minimal efficiency, needed for the sheer **survival** of the system;
- Maximal efficiency, the system being pushed to its maximal **level** of **activity** compatible with its **survival** within the **environment** which provides it with its **inputs**. In such a condition, the system can easily cross some dangerous **instability threshold**;
- Sustainable efficiency, which guarantees that the system should be able to maintain its **activity** for long **time** through a well-balanced use of its **environmental inputs sources**.

H. ODUM gives the curious following example: "The elimination of fire from pine woods sets the stage for disastrous fires twenty years later" (1971, p.226).

This suggests that even the qualitative aspects of efficiency should be carefully considered. It also implies that **short term** efficiency may very well be incompatible with **long term** efficiency. This last observation may have an ominous **significance** for the present **hyper-efficient** use. of natural **resources** by **human systems**.

Still, **instability thresholds**, crossed because of such hyper-efficiency, may also lead to the **emergence** of more **complex systems**.

1036

EGALITARIANISM⁴⁾

A **behavior** in social systems in which everything is shared equally and selfish **behavior** is severely punished" (L. DICKS, 2000, p.33)

Egalitarianism seems to have the effect of weakening the need for individual **selection** and strengthening group selection. In this way, the **group** provides a global **adaptation** to the **environment** which results in a new type of advantage for all members: to receive help from others when needed and to benefit from more favorable general conditions of existence. This can be seen in anthills or beehives, as well as in any type of human societies.

The need to eliminate cheating in order to save solidarity explains the severity of punishment for selfish behavior. An extreme case was impalement as punishment for cattle theft in some Congolese Central African tribes.

1037

EICONICS¹⁾

A general science of the **images**.

Eiconics was proposed by K. BOULDING (1956) as a result of his inquiry into the nature of **images**. He wrote: "... in the concept of a **message-image relationship** there is a conceptual and theoretical **scheme** of remarkable unifying power. It is one important thread that seems to run through a number of different disciplines and sciences" (1961, p.148).

BOULDING's proposal did not catch on until now. However, a new **language** of ideographic **signs** worldly understandable is now progressively emerging and one also wonders if the main concepts of systemics and cybernetics could not be translated to an "eidetic" **language**, which would be highly understandable at all educational and cultural **levels**.

1038

EIDETIC ¹⁾⁵⁾

Related to perceived **images**.

According to G. BATESON (1979, p.228): "A mental **image** is eidetic if it has all the characteristics of a **percept**, specially if it is referred to a sense organ and so seems to come in from the outside".

We are of course left with the need of a more precise understanding of the connection between the "outside" and the "inside", i.e. the way the percept is transformed in a "mental image", and even what is exactly a "mental image"

1039

EIGEN ²⁾

A German word whose meaning is "Self".

The German prefix "eigen" means "own" and is now used in various composite words, all of them introduced by von FOERSTER (1976, p.93) and related to the **self-reproductive** properties of **autopoietic systems**, endowed with **organizational closure**. von FOERSTER wants to emphasize the **self-reference** nature of systemic **processes** and **functions**.

He even states in a paper in German that "Leben ist ein Eigenprozess" (1992, p.82), and adds: "A living being is a self-perpetuating, autonomous and organizationally closed being".

This basic characteristic was confirmed later on by H. MATURANA, F. VARELA and R. URIBE's biological research and simultaneously extended to psychology and sociology under the guise of **constructivist concepts**. (E.von GLASERSFELD, in P. WATZLAWICZ (Ed), 1992).

We thus have "Eigen-algorithms, Eigen-value, Eigen-behavior, Eigen-elements, Eigen-functions, Eigen-operators, Eigen-processes" and, in **communication**, "Eigen-feedbacks", which become the origin of "**conversation**" and **consensus** through progressive agreement on **perceptions**, **meanings** and **concepts**.

In all cases, "Eigen-situations" need to be carefully harmonized with their own origins (**autogenesis**) and all **transformations** and evolutive **changes**, like **adaptativeness** and **emergence** of higher **levels** of **complexity**.

1040

EIGEN-ELEMENT ^{1) - 2)}

An **object** as perceived by an **observer**, or **operator**.

The element becomes "eigen", because of the **process** of **observation**, specific of any individual **observer**. It tends moreover to become stabilized through repeated **observations**, in a specific way proper to the given **observer**. (Crf. "Hebb's rule")

R. VALLÉE extends the concept to "the case of two subjects observing each other and themselves" (1984, p.25).

1041

EIGEN-STATE ²⁾

"Closure of a certain **state** under an **operator**" (F. HEYLIGHEN, 1990b, p.500).

The same **state** repeats itself in a **cyclical** or **hypercyclical** way.

As observed by C. HENRY and L.M. ROCHA (1996, p. 543), von FOERSTER's Eigen-states are in fact **attractors**.

1042

EIGEN-TIME ²⁾

The internal **time** of a system.

Systems appear to possess a kind of internal clock, related to their internal **dissipation** of **energy**. P. WINIWARTER and C. CEMPEL write: "The **accumulation** of **dissipation energy** in the form of internal structural quanta within a limited potential leads from "birth" to "death" of the system. Time is expressed as internal time, or eigen-time, starting at 0 and ending at **breakdown b**" (1992, p.23). While these authors study basically the case of mechanical systems, the French biologist P. LECOMTE du NOUY established that each **living system** has its own biological time (1936). The BETHE **cycle** can also be considered as the Eigen-time clock of **stellar systems**.

The existence of the eigen-time implies that no **homeostatic** system can be eternal. A better **knowledge** of this topic could lead to a clearer **understanding** of the cause and nature of the characteristic **life span** of specific systems.

1043

EIGEN-VALUES ²⁾

The series of self-produced repeated and stable values that result of **recursive operations** in a **organizationally closed** system.

H.von FOERSTER, who introduced this partly German term, states: "... Eigen-values are discrete (even if the **domain** of the primary argument obs₀ is continuous)..."

"... Eigen-values represent **equilibria**, and depending upon the chosen **domain** of the primary argument, these **equilibria** may be **equilibrium values** ("fixed points"), **functional equilibria**, **operational equilibria**, **structural equilibria**, etc.

"... Eigen-values, because of their self-defining (or self-generative) nature imply **topological "closure"** ("circularity")" (1976, p.93).

Also in von FOERSTER's words: Eigen values are "**equilibria** that determine themselves through circular **processes**" (1981, p. 280). In a sense they are **attractors**.

As a result, any **observer's** view of reality is always self-constructed. In von FOERSTER's words: "**Ontologically**, Eigen-values and **objects**, and likewise, ontogenetically, stable **behavior** and the manifestations of a **subject's** "grasp" cannot be distinguished. In both cases "**objects**" appear to reside exclusively in the **subject's** own experience of his sensory-motor **coordinations**" (p.94).

Some measure of "**objectivity**" can be attained only through comparison by two or more **observers** of their respective sensory-motor **coordinations**, which may lead to a **consensus**. Such **consensus** is always liable to be revised, which gives a supplementary foundation to POPPER's falseability of theories and KUHN's **paradigm** shifts.

1044

EISENHOWER GRAPH

→ **Assumptions rating chart**

1045

EKISTICS ¹⁾²⁾⁴⁾

The science of human settlements.

Ekistics views any human settlement as a living **organism** having its own laws and, through the study of the **evolution** of human settlements from their most primitive phase to megalopolis and **ecumenopolis**, develops a **transdisciplinary** approach in order to better manage its problems.

These views were introduced by C.A. DOXIADIS, a greek architect and urbanist, from 1942 on.

The goal of ekistics is to develop a **methodology** and **models** to study any kind of human settlements, of any **size**, **location**, **population** and **biotope**, in order to draw general conclusions in each case.

Ekistics studies each settlement as a **whole**, integrating all of its **elements**.

According to DOXIADIS the five elements which compose human settlements are: nature, anthropos (man), society, shells and networks.

Ekistics includes a territorial **scale** of classification based on the respective areas of territories. The scale starts from the total habitable land area of the planet (about 136 million km² Antarctica excluded). It is based on Christaller's **hexagonal space filling** concept. The scale extends for 17 **levels**, starting from the total habitable planetary **space** to the basic unit considered to be 4 m² as a minimum requirement for an individual.

Ekistics also includes "population units": Unit 1 being the individual; Unit 2 two individuals; Unit 3 a medium family of 5 members and so on at a **logarithmic scale**. Each unit is supposed to be 7 times larger than the lesser one.

DOXIADIS also introduced the concept of "**ecumenopolis**" as the coming planetary organization through which "anthropos" is destined to cover the whole earth as a continuous system forming a universal settlement. This corresponds to the **man-planet system** as it is presently coming into existence.

→ **Biosphere; Eco-cube; Ecological model of the man-planet system; Ecology; Socio-cultural system; Socio-historic system; sociosphere; Sociotechnical macrosystem**

1046

ELABORATOR ²⁾

A natural organ or artificial device able to translate perceptive **data** collected by the **receptors**, into a **language** suitable for the systems use.

J.G. MILLER uses in a very similar sense the term "**internal transducer**".

A. LOTKA described as follows the **role** of the elaborator: "...combine and further elaborate the crude **information** furnished by the senses". He added: "The physical location and **structure** and **mode of operation** of the elaborators is much less obvious than that of the **receptors**" (1924, 1956, p.339-40). Despite 70 years of research, since 1924, this is still largely true nowadays, even if the construction of artificial **correlations devices** is now improving our **understanding** of the natural devices.

1047

ELEMENT ^{1) - 2)}

The minimal **components** of a system such as their total **set** and the global **set** of their **interrelations** form the system.

According to I.V. BLAUBERG, V.N. SADOVSKY and E.G. YUDIN: "Since the element appears as a kind of limit for a possible **decomposition** of the **object**, its own **structure** (or composition) is usually disregarded in the characterization of the system..." and, "... in general an **element** cannot be described outside its functional characteristics: from the point of view of the system's **wholeness** it is not the **substratum** of the element which is of primary importance, but what it does within a **whole**, what **functions** it performs in it" (1977, p.139).

As the concept of element is also used to denote a mathematical basic **part** of a **set**, it becomes a link toward formalized **models** of **concrete systems**. However, such **models** should better include the specific **interactions** between the elements, and still better, the **rules** defining these **interactions**.

1048

ELEMENT and the AUTOPOIETIC SYSTEM (The) ^{1) - 2) - 4)}

F. ROBB writes: "The **relationship** between the individual and the institution is **asymmetric**. The **autopoietic organization** does not depend on any particular individuals, but it does use and constrain individuals to serve its own ends. Indeed, it must turn over individuals in order to preserve itself. Such **organization** uses human lifetime and stored skills, experience and **knowledge**, simply as a **resource** to maintain its **autopoiesis**" (1990, p.396).

This **asymmetric interrelation** is also present in **living systems** in general. It suffices to replace the word "individual" by "element" or "**component**", and "institution" and "**organization**" by "system".

However, while elements are submitted to systemic **closure** in physical systems, they also remain transient in these entities.

This seems similarly to be the case in artificial systems, as for example in a plane, or a computer ("spare **parts**").

1049

ELEMENT (Frozen) ²⁾

An element in a **network**, unable of changing its **state**.

St. KAUFFMAN explains this as follows: "In (a) small sample **network**, all the elements (may be) **ruled** by **Boolean OR functions** and (be) all initially off. **Changes** cascade through the system after one element is turned on. Because of the **configuration** of the **network** and the **Boolean functions** involved, some elements freeze into the on **state**. Thereafter they will return to that **state** even if they or one of their **inputs** is altered" (1991, p.67).

This is a very interesting property, the base of what KAUFFMAN calls "**antichaos**", i.e. progressive **organization** of **random networks**. This author explains: "Why do **random networks** with two **inputs** per element exhibit such profound **order**? The basic answer seems to be that they develop a **frozen core**, or a connected mesh of elements that are effectively locked into either an active or inactive **state**. The **frozen core** creates interlinked walls of **constancy** that '**percolate**' or grow across the entire system. As a result, the system is partitioned into an unchanging **frozen core** and islands of changing elements" (p.67).

This very simple **mechanism** seems adequate for the modelization of numerous and seemingly unconnected properties of different kinds of **networks**. **Memory**, some neurotic or psychotic **states**, stable cores in **languages**, basic social **structures** could be examples.

Frozen cores, interestingly, appear also in some of CONWAY's **games of life**, by recurrent application of very simple **rules**.

1050

ELEMENT (The inside) PROBLEM ^{1) - 2)}

When included in a system, an element loses all or part of its potential for **autonomous activity**. This is a very significant feature and, moreover, one whose consideration is of utmost importance for the study of human systems.

1. Differences between a free and a binded element

a) A free element interact directly with its **environment** and does not depend to do this from other elements, with whom its **interactions** are nil or very slight.

On the contrary, the binded element depends on quite specific and repetitive **interactions** with some, or many, other elements and these **interactions** make sense and are maintained only within the **frame** of a more complex and generally **hierarchical** entity.

b) In some very special cases we may observe how free elements become more or less binded ones, as for example in the **transition** from individual to social **phase** of *Dictyostelium discoideum* (see J.T. BONNER, 1955, p.104ff, and more recently A.T. WINFREE, 1980, p.337-44).

We ourselves, as participants of ever wider **sociosystems**, possibly are engaged in a similar **transition**.

→ "**Meta-system transition**".

2. Progressive binding

Transition from free to binded is for elements, a progressive one. However, two different **situations** should be considered.

a) in the case of a new type of systems in the making (presocial **situation**, most specially in **human systems**), the element progressively replaces direct **interactions** with its **environment** by indirect ones, through new **interactive** elements and, in some cases, very complex chains of these **interactions**: We now buy bread from the baker, and have no more need to till the field, to sow, to reap, etc, etc. In this way, privileged and interconnected **interaction zones** in **space** and **time** are created and a common **boundary** or **interface** appears, made of elements specialized in **specific interactions** with the **environment**.

b) in the case of a new system, already endowed with **organizational closure**, for instance a newborn baby, there is a phase of **morphogenesis**, during which the elements become selectively interconnected within more or less precise **limits** (St. KAUFFMAN's **frozen cores**).

3. Levels of complexity in binding

In accordance with SIMON's **concept** of **hierarchical complexity**, elements generally bind at their own **level of complexity**: atoms with atoms, molecules with molecules, ants with ants and men with men.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Moreover higher **levels** of **complexity** can appear only when lower **level** building blocks of the suitable **classes** exist in sufficient numbers.

At each **superior** level of **complexity**, new potentialities appear: the more **complex system** becomes able to develop more intricate **activities**.

4. Do the element "understand" the system in which it takes part?

This question mark is of course anthropocentric. Moreover quotes are used because we do not know what could correspond to "understanding" at the molecular **level**, nor even among bees or ants.

In any case, it seems improbable that the **part** could be totally aware of the **whole** and of the significance of the **whole's activity** in **time**, still less than in **space**.

This problem is, indeed, a portentous one for mankind.

1051

ELEMENTS as COMPONENTS ¹⁾

When elements combine with each others, their individual properties become deeply modified.

An hydrogen atom when independent, possesses characteristics which become hidden and merely potential when combined within a water molecule. This last one, in turn, is modified when included in a **cell** (as a **part** of some biochemical product) and the **cell** itself, included in an **organ** acquires and loses some properties.

Such is also the case in **composite systems**: a migrant locust within a flight of millions of other locusts loses some of its individual **patterns of behavior** and acquires others, as for example a permanently defined flight orientation.

It is however in the strongly **integrated systems** that the elements are most modified, up to the point that their new characteristics become irreversible: they cannot anymore return to an independent **state**, nor survive if severed from the system.

The terms "element" and "component", while widely used as synonyms, have thus somewhat different **meanings**.

"Element" implies an overtone of basic simplicity and clearly defined individuality, which are at least partly results of the way we reduce the system to its **parts**. "Component" is characterized by its membership in the system.

1052

ELIZA ³⁾ - 5)

A computer **program** for the study of natural **language communication** between man and machine.

This **program** was created in 1966 by J. WEIZENBAUM (1976). It is able: "... to *mimic* a non-directive psychotherapist interacting with a "patient".

The following comment by M. RINGLE puts "ELIZA" in perspective (in accordance, it should be observed with WEIZENBAUM's own ironic viewpoint): "A.I. workers have often sought to build computer **simulations** which operate on superficial **behavioral similarities** to natural **intelligence**, rather than on the underlying **cognitive structures**. A good example of this is WEIZENBAUM's "ELIZA". ELIZA will, at least for a short time, give the impression of a sophisticated **semantic** analyzer-and-synthesizer. After a while, however, the impression will diminish as ELIZA repeats stock phrases in order to acquire more **syntactic informations**. In fact, ELIZA is simply a clever **syntactic** device, a "conversation-continuer" which lacks a **semantic** interpreter altogether" (1976, p.9).

In this case programmed "parrot speak" has been made clearly different from **artificial intelligence**, at least if one admits that **artificial intelligence** could be not purely **algorithmic**.

1053

ELLIOTT's WAVE ¹⁾²⁾⁵⁾

A **pattern** in the evolution of stocks prices first described by Ralph ELLIOTT, a californian accountant (after being ruined by the Wall Street crash of 1929)

Elliott discovered the existence of more or less regular patterns in the alternance of ups and downs of stock markets in general, and in most stocks in particular

While specific movements are individually **random** they seem to compose in **time** a kind of statistical or possibly chaotic **determinism**. Elliott discovery was based on **long term** graphics of stock quotations. It derived into a so-called "technical analysis of stock trends" through the study of certain characteristic patterns, which are supposed to have some forecasting usefulness.

This "chartist" method is widely described (with graphics) by J. CASTI (1990). It is completely at variance to the common financial and economic studies of stocks, which are totally ignored.

In fact, the chartists graphics seem to reflect the psychological aspects of stock trading (the famous "Bulls" and "Bears"). They present some interesting characteristics:

- The graphicated curves show sudden **trend ruptures** (in the style of R. THOM's "catastrophes")
- While all graphics are apparently highly irregular, it seems that **short-term** trends are imbricated in **medium** and **long term** trends. Possibly even these longer trends are some-

how constructed in a **cumulative** way through the shorter movements.

- This last feature seems to indicate that these curves are fractals, or at least imperfect ones
- The **self-similarity** at different time-spans could be interpreted in terms of **WEIERSTRASS renormalization group transformation**

The Elliott **wave** could also be somehow related to the **KONDRATIEFF cycle**, and even with SCHUMPETER's "creative destruction" model

Untill now, the whole subject remains ill understood and also under-researched. There is surely more in it than the generally recognized **random walk** model.

1054

EMANCIPATORY SYSTEMS APPROACH ¹⁾²⁾⁴⁾

M. JACKSON writes: "The concept of emancipation is a much contested one in **systems thinking**, as it is in social theory more generally. There are arguments about whether we should be seeking human emancipation, or individual emancipation or, indeed, whether non-human **elements** such as other species or the **environment** should be considered as well..." (2000, p. 291)

After describing a number of versions of the emancipatory **concept**, Jackson adds: "All emancipatory systems approach are suspicious of the current social order and seek to radically reform it. They see society as presently constituted, as benefiting some **groups** at the expense of other groups, which are suffering domination or discrimination".

And "Usually the **process** of emancipating the oppressed can also be seen to have benefits for the oppressors in the new social order" (Ibid)

This is of course a trend universally verified in the whole history of humanity.

Jackson proceeds thereafter, presenting various proposals, among them:

- Habermas' critical systems approach
- **Interpretive systemology**
- Freire's critical psychology
- MacIntyre and the moral community
- Capra's ecological sustainability

Most of these proposals, save possibly Capra's are quite weak in their deeper (i.e. not merely **ideological**, descriptive or **mechanistic**) description of the domination process in whatever **culture** or society of the past or the present.

Jackson's conclusion- at least provisional- is that "Emancipatory thinkers may be inviting the oppressed simply to enter into new relations of domination" (Ibid, p. 309)

Having stated what "should" be done—namely to "emancipate"—it would be necessary first to make clearer what is meant exactly by "emancipation" and secondly, what should be efficient and practical ways to reach such a desirable state.

→ **Assumptional analysis; Action theory; Awareness; Dominance; Frankfurt School; Search conferences; Social systems theory and design; Sociality; Sociobiology; Sociogenesis; Sociognosis; Sociolysis; Sociotechnical system**

1055

EMBEDDEDNESS

→ **Embedment (of which it is sometimes used as a synonym)**

1056

EMBEDMENT²⁾

The situation of a **component** or a **subsystem** within a system of higher **complexity**, to which it is subservient.

B. BANATHY writes: "...most systems embed other types (of systems)... In **complex systems** — as a rule— we find various layers of embeddedness of systems that represent several types. It is important to recognize the potential of such embeddedness and the need to approach the various embedded and embedding systems with the use of **methods** that are appropriate to the particular system type. For example, an industry based corporation may have embedded in it a large number of assembly line (rigidly **controlled** type) systems, that are embedded in several production (**deterministic** type) systems, that are embedded in corporate **management** (**purposive** type) systems. Another arrangement of embeddedness can be observed in a large research and development **organization**. Specific projects in such an **organization** operate as **deterministic** systems. Project **goals** and **objectives** are set by grant or contractual arrangements with **freedom** limited to selecting **means/methods**. Projects are clustered in **programs** that operate as **purposive systems**. and **programs cluster** in **program** areas that are of the **heuristics** type. The R&D **organization** that embeds these **program** areas behaves as a **purpose seeking system** type in constant search of new **domains** of research, new niches in the **environment**. Designing a project system that has clearly defined programmatic, financial, legal and time **boundaries** requires a **design** approach and **methods** that are very different from those that are to be used in designing or redesigning the entire R&D **organization** as a **purpose seeking system**, which has only broadly based policy guidance and rather open **program boundaries**" (1988, p.30).

NUMELLA CAINE and M. CAINE write: "... the fact is always embedded in multiple **contexts**, and a **subject** is always related to many other **issues** and **subjects**. The capacity of schools and society to optimize **learning** and realize the potential of the human **brain** depends on their capacity to deal with their **interconnectedness**." (1994)

A. ZELEZNIKAR, referring himself to **information**, writes: "... embedding is an accumulative and integrative **process** in informational sense... It is the basic principle of appropriation of **information** by **information**. By embedding, the outside or inside unconnected **information** comes into consideration by the entity which embeds" (1993, p.58).

Embedding dimension: "The number of dimensions needed to completely encompass an **attractor**" (J. CASTI, 1994, p.105).

Noninteger dimensional numbers are "strongly indicative of underlying **chaos** lurking in the **data**" (Ibid.).

Embedding (Transitive): "A **process** in which intellectual technology is employed to convert a **set** of collective **perceptions** into a **matrix model** of the **structure** of a system" (J. WARFIELD, 1989, p.298).

Such **model** "represents an intermediate product in a larger **process** aimed at developing insight into **complex systems** through the development of interpretive structural models" (Ibid.).

1057

EMBRACE

→ **Fatal embrace**

1058

EMBRYOGENESIS^{1) - 5)}

The **dynamics** of **development** of an **organism** or **organization** from its **autogenesis** to the **irreversible development** of its basic **processes** and **structures**.

This concept can be translated in a more or less **analogic** way from biology into **systemics**: any new **social system**, as for instance a new business, or institutional **organization**, or a new nation undergoes this type of original **structural** and **functional development** until it reaches a **viable state**. The latter is precisely characterized by a more or less complete dynamic **stabilization** of the critical **interrelations** between the **parts** of the new system.

1059

EMERGENCE^{1) - 2)}

1. "The spontaneous **transformation** of a **set** of **components** from a less coherent **state**, where the **space-time correlation** between them is confined to mean free **path** and mean relaxa-

tion collision times, to a more coherent **state** exhibiting novel, global, **dynamical space-time behavior**" (R. SWENSON, 1989, p.188).

2. "Any **process** whereby the **variety** and/or **constraint** of a system changes" (F. HEYLIGHEN, pers. comm.).

Emergence implies **discontinuity** and innovation in the construction of **complexity** (W. KARGL, 1991, p.579).

G. PASK, for instance described **functional** emergence as the recognition "by an external **observer**" that "a device or **agent** has acquired a new **distinction**, **concept**, **structure**" (P. CARIANI, 1993, p.28).

SWENSON comments that this new coherent **state** is: "many order of **magnitude** greater than mean free **path** and **relaxation** times; inaccessible to, not locatable in, and not reducible to the individual or summative **behavior** of the separated atomisms" (i.e. **elements** or **components**); "the spontaneous creation of a new **set** of macroscopic **constraints** that reduce accessible microstates from some initial **set** *M_n* to some much smaller subset *M_s*, to yield a new irreducible level of **dynamical space-time behavior**. By the **transformation** *M_n* to *M_s*, emergence is always a progressive, **asymmetrical** time-dependent **transformation** of **matter** away from **equilibrium**" (p.189).

Emergent systems are thus always more complex and less stable than their **components**. They derive from the appearance of an **emergent attractor**. Ch. LAVILLE's concepts about **vortexes** (1950), and recently D. McNEIL toroidal model of the system (1993a and b), suggest that such **attractors** are produced by opposing energetic **fields**.

HEYLIGHEN states: "The emergence of systems of (partially) conserved **distinctions** cannot be deduced from the properties of lower-level "microscopic" **distinctions**, but may be understood as a **process** of **self-organization**, governed by **variation** and selective retention" (1989, p.382).

J.P. CHANGEUX in turn states: "The highest **levels** (of **organization**) emerge progressively throughout biological **evolution**. They superpose and **embed** the inferior **levels**, themselves selected during former evolutive steps (1992, p.707).

HEYLIGHEN also writes: "... such a **process** will necessarily change the **identity** of the system itself. It might therefore also be called a **system transition**. This is a qualitative **change**, where a new **organization** or system appears, with properties (potential appearances) that did not exist in the old system. The more usual ("quantitative") dynamical **evolution** of a system, on the other hand, is merely a **transition** within the constrained **variety** of possible appearances, where neither **constraint** nor **variety** undergo any **change**" (Ibid).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This **concept** is quite different from SWENSON's, but closer to PRIGOGINE's. Here dynamical **evolution** (or better, **adaptation** or **accommodation**) remains in accordance with the **organizational closure** of the system, which is replaced, or at least transformed, in case of emergence.

Examples may better emphasize differences.

A running athlete **accommodates** him/herself to the effort by breathing rapidly and strongly, but only for a short time.

One who must go to live for years in some high altitude place, **adapts** permanently his/her respiratory capacity to this **change**.

The first animals who left the oceans underwent a radiative **evolution** of emergent types, changing branchial for aerial pulmonary breathing.

1060

EMERGENCE and REDUCTION ²⁾³⁾

Any good **understanding** of a **complex system** requires a well integrated understanding of the **relationships** between emergence and reduction.

Properties of a **whole** cannot make full sense if not sighted as a global **network of interactions** between **parts**, which in turn must be duly considered as such.

A very simple example is the study of water (H₂O).

Its properties are widely different from those of hydrogen and oxygen. However, the characteristics proper to these molecules (for example their electrons shells) are basic for the understanding of common (or heavy) water. This becomes still clearer when we consider for example the hydrogen atom within the HCl molecule.

It is commonly said that the whole is more than its parts.

It is however in a sense also less: as atoms enter in **combination**, they actualize potentially possible relationships, but also preclude others.

In short emergence and **reductionism** offer complementary and necessary views and it is a gross mistake to oppose them in an exclusive way.

In this 1996 paper, K. BAILEY offers important insights about the ways we should use what he calls the upward ladder (**bottom up**) and the downward ladder (**top down**).

1061

EMERGENCE BY RANDOM FLUCTUATIONS ²⁾

Any **composite system**, while endowed with **dynamic stability** at its own **macrolevel** (as being in a **state of thermodynamic equilibrium**), may undergo **random fluctuations** at a **microlevel**.

Such **fluctuations** may become amplified, by **positive feedbacks** and grow to the point of creating higher **level macrostructures** within the system. Endly, they may be stabilized by **negative feedbacks**.

The global result is a new global **behavior**, that was not initially predictable. In J.de ROSNAY words: "Each **random fluctuation** is a possibility of new **organisation**, implying a kind of **information**. When amplified by a **positive feedback**, any **fluctuation** becomes a **random variety generator**, base of any **evolution**" (1975, p.226).

It seems that **emergence** of a higher **level of complexity** is possible only in **composite systems**, wherein the **elements** possess initially a considerable degree of **autonomy** and are all quite similar. Their ordering by structuring **fluctuations** which become fixed seems to be the basic **process of organization of heterogeneous social systems**, i.e. **complex systems**. If such is the case, what ROSNAY calls "**evolution**" should be better named "**complexification**" or "**integration of complex systems**".

1062

EMERGENCE (Social) ^{2) - 4)}

The emergence of a higher **level of integration** in **complex systems** through the functional **association of heterogeneous groups of elements** of lower **complexity**.

Complex systems must by necessity be **heterogeneous**, i.e. made of various complementary and interconnected **subsystems**.

Such **subsystems** are generally composed of a great number of similar **elements**, which have common requirements for their survival. However, it is frequently useful for such **groups** to enter in **symbiosis** with other **groups** of different characteristics. This **process of association** repeats itself through a number of **complexity levels**.

It has possibly been at work from the nuclear and atomic **level** on, and is also probably currently active with the progressive **emergence** of a planetary society.

1063

EMERGENT PROPERTIES ²⁾

1. "Properties of a structural **level** in a **hierarchy** that cannot be predicted from the properties of the **components** of the antecedent **level** (R.F. FOX, 1988, p.171).

2. "a) Properties which emerge as a coarser-grained **level of resolution** is used by the **observer**.

b) Properties which are unexpected by the **observer** because of his incomplete **data set**, with regard to the **phenomenon** at hand.

c) Properties which are, in and of themselves, not derivable a priori from the **behavior** of the **parts**" (T.F.H. ALLEN & T.B. STARR, 1982, p.267).

A good example of emergent property can be found in a system's **autonomy**. N. PEGUIRON describes the following very simple **situation**: "Let us consider an elemental electrical circuit made up from a relay and two switches: the first normally open serves to start the current within the coil of the relay, but it can be seen that this action is conserved when one stops to press the switch; the second one, normally shut, has the opposite effect, but the same property. This very simple circuit presents the property to memorize the last performed commands however this memorization property does not belong to any of the **elements**. As long as the coils, the contacts and the switches are separately studied, it is not possible to understand, nor to predict the global property of memorization. This property is said to be emergent because it is found neither in the **components** of the system, nor in their assembled **state**" (1989, p.9).

It appears only when the system is connected functionally with its **environment**, the grid.

Numerous other examples of emergent properties can be given, as for example:

- life, in relation to macromolecules
- **consciousness** as a result of numerous **interconnexions** between neurons
- a working car, as a meaningful and functional assembly of **parts**.

Water as a liquid, while its **parts**, hydrogen and oxygen are both gases in their elemental state

1064

EMERGENT SYSTEM (Properties of the) ¹⁾

A WILDEN enumerates the following properties, as characteristics of any emergent system:

- An increased **adaptive range**
- An increased **viability**
- An increased **variety (complexity)**
- Structural innovations
- A new organizational **order**
- The shaping of modified **subsystems** (later on)
- An enhanced **selectivity**
- Changes in **adaptive order** and **learning**
- An increased mnemonic capacity
- More varied **simulations** possibilities
- Increased opportunities for changing **goals**
- An increase of the systems **sensibility to noise**"

"The **2nd. order negative feedback** under the guise of emergence, implies thus a recodification or **renormalization**, in the sense of restructuration" (1972, p.62).

1065

EMERGENTISM (Rational)³⁾

"The philosophy that combines an acknowledgment of **emergence** with the thesis that **emergence** is explainable and predictable within bounds" (M. BUNGE, 1979, p.251).

According to BUNGE, this proposal "supercedes both atomism (though not its allegiance to science) and **holism** (though not its insistence on **emergence**)" (Ibid).

Predictability "within bounds" has probably its roots in PRIGOGINE's **emergence** through **dissipative structuration** and **bifurcations** in **systems far away from equilibrium**.

1066

EMERGY¹⁾

"The total amount of **energy** embodied in the creation of some thing or conditions, and bringing it into a certain place, **state**, and **time**".

This neologism has been introduced by H.T. ODUM. (1988, 1991)

Another definition given by D.R. TILLEY, of Environmental Engineering Department of University of Florida reads: "A system property that related all **flows** and **storage of energy**, materials and **information** to the one form of source energy required for their formation and **maintenance**" (1998, p. 178)

According to this definition, it becomes possible to use "emergy accounting as a rigorously quantitative tool for valuing and comparing the work of nature with that of humans" (Ibid)

The idea that nature is "working" and in fact leaving its products at our disposal for free is generally ignored in **economics**. As a result, we are plundering nature's **ecosystems**, without making any distinction between capital and "interest". There is a wide misunderstanding of the need to respect self-maintenance of nature as a bedrock base for the **dynamic stability** of our own socio-economic systems.

The **concept** seems very important, because in many cases a quite significant part of the **energy indirectly** used up in a productive **process** is left out of economic **evaluation**.

MACHLUP and PIMENTEL have shown that many products – particularly agricultural ones – are heavily subsidized in **energy** terms and, finally produce a clearcut **energy** deficit, i. e. do not compensate the energetic investment involved. (1977).

→ **World engine**

1067

EMPIRICAL VIEW in systemics³⁾

E. LASZLO developed a systemic view of empiricism, quite close to SINGER's, CHURCHMAN's and ACKOFF's "**experimentalism**": "Empirical **facts** lie where theory meets nature: there is no **fact** without theoretical conceptions, just as there is none without an observational content. The meeting of theory and na-

ture defines the plane of **observation** and experiment: that is the realm of **fact**" (1987, p.178).

What LASZLO calls "empirical adequacy" is thus strongly influenced by various systemic viewpoints:

- **facts** should not be isolated from **context**
- **facts** may respond to different levels of **abstraction**
- **facts** are not independent from the **observer's perceptive frames of reference**.

1068

ENACTON THEORY³⁾

A theory of **cognition** which considers it as inscribed in the body.

This theory, introduced by F. VARELA et al (1993), is influenced by Buddhist traditional psychology, and constitutes also a development of MATURANA and VARELA's concept of **auto-poiesis**. It proposes an integrated approach to the so-called "mind-body" problem, as the body is the place wherein perceptive and cognitive **mechanisms** are elaborated as subjective **cognition**.

1069

ENANTIODROMIA^{2) - 3)}

"The coexistence of opposite but complementary **processes**" (H. & L. SABELLI, 1992, p.661).

H. and L. SABELLI's **process theory** "...postulates the existence of complementary opposite **processes** of **evolution** and **involution**" (p.683).

In their view, **process theory** "expands the **second law of thermodynamics**, postulating a more general hypothesis: **processes** tend to **symmetry** – including not only the point **attractor** of **entropy**, **disorder** and rest, but also complex **attractors**, chemical **structures**, biological **organisms** etc." (1992, p.661).

According to SABELLI this term was introduced by HERACLITUS and adopted by C. JUNG.

The concept could become a framework for the complementary entropy and **negentropy** ones.

1070

ENANTIOMORPHS (or ENANTIOMERS)⁵⁾

Crystals of similar **form** but that cannot be superimposed, as one is the mirror **image** of the other.

Such a type of inverse **symmetry** – known as **chirality** seems to be a very basic feature of **organization** in systems. It was discovered by L. PASTEUR (1822-1895) (levogyre and dextrogyre crystals of tartaric acid)

Complementary enatiomorphic crystals derive polarized light either toward the left, or toward the right respectively.

The same **phenomenon** appears also in biology, as for example in the opposed **complementarity** form of the human hands. It is obviously a specific case of the general opposition of symmetry and anti-symmetry.

→ **Chirality**

1071

ENCAPSULATION²⁾

The **process** that leads to the enclosure of a number of former independent **elements** within closed **boundaries**.

Encapsulation could be considered the **process** that leads to **capsulation**, interpreted as its result. Both seem to be related to so-called **frozen structures** and the shaping of **subsystems**.

1072

ENCODER^{1) - 2)}

"The **subsystem** which alters the **code of information input** to it from other **information processing subsystems**, from a "private" **code** used internally by the system into a "public" **code** which can be interpreted by other systems in its **environment**" (J.G. MILLER, 1978, p.3).

The encoder is one of the **20 critical subsystems** in MILLER's **taxonomy of living systems**.

1073

ENCODING²⁾

The act of producing a **message** (R.L. ACKOFF & F.E. EMERY, 1972, p.190).

The **encoder** must be able to make satisfactory **correlations** between its/his/her own internal **code** and the general **communication code**, whose **rules** must be precisely defined.

These are the conditions for the efficient **transmission** of a meaningful **message**.

Accordingly some **rules** of correspondance must be defined and respected, considering distinct aspects of encoding:

- the proper modulation of some physical **phenomenon**, as light or electromagnetic pulses, or sounds as for example tomtom beating or the human voice;
- the use of some specific **language** understandable by the **receiver** as well as the sender;
- the correct **syntactical** and **semantical** use of such a **language**.

1074

ENCODING: Its limits ²⁾³⁾

M.H. BICKHAR and L. TERVEEN observe the existence of an implicit assumption according to which all **representations** have the nature of encodings. They call this assumption "encodingism" and state that any programmatic research predicted on it is doomed to distortion and ultimate failure (1996).

The basic reason of this limitation is that encodings are strictly **constrained** and cannot produce more than their intrinsic **content**.

The authors propose "Interactivism" and **connectionism** as an alternative model of **representation** and explain the foundations of an interactivist architecture in Artificial Intelligence.

1075

ENCOUNTER PATTERNS ²⁾⁴⁾

The result of the progressive ordering of multiple unplanned encounters among a great number of individuals.

It leads to the establishment of selective **behaviors** and favored routes.

Such a **behavior** can be observed among foraging ants or bees. They probably result of the superposition of:

- a general diffuse **determinism** related to the ecological setting of food sources
- an also diffuse behavioral **determinism** produced by some biological socially generative factor, in these cases, **pheromones**
- a genetic behavioral pre-conditioning in individuals. Similar factors, but at a much higher level of **complexity**, are probably at work in the construction of **neuronal networks** in the **brain** and also in human societies.

→ **Crowding effect; Dictyostelium discoideum; Order parameter; Parallel distributed processing; Stigmergy; Swarm.**

1076

ENDECHY ¹⁾

The sum of the ordered part and the disordered part of the internal **energy** of a system.

This concept has been introduced by J.F. SCHOUTEN (1953, p.199-204). It can be considered as "a measure of the *a priori* possible configurations of the **parameters** of the system under consideration" (p.202).

If we consider **open systems**, we are led to the intriguing query to find out if a *mature* system would still be able to better the ratio **order/disorder** once stabilized, and, if so, how, at what **cost** and with which results.

1077

ENDOGENOUS ¹⁾

"Deriving from within the entity or system" (T.F.H. ALLEN & T.B. STARR, 1982, p.267).

1078

ENDOGENOUS DEVELOPMENT ^{1) - 2)}

The internal differentiation of a system under the limiting pressure of its **environment**.

As a system disposes of a considerable **energy flow** it may at its beginnings expand freely until it reaches spatial or energetic **limits**. It may however still be able to better its **efficiency** by a more differentiated internal **organization** and less wasteful use of its **inputs**.

1079

ENDOMORPHISM ¹⁾

"Autonomous individualization whose development rules are internal and given once and for all" (F. BAILLY, F. GAILL & R. MOSSERI, 1991, p.58).

These authors use as an example the biological development based on the genetic **template** and relate it to VARELA's **organizational closure**.

It would be interesting to scrutinize eventual possible extensions of the **concept** into psychology and sociology (the **values** system of a culture as a **template**).

1080

ENDOSTRUCTURE

→ **Exostructure and structure**

1081

ENDOSYMBIOSIS ^{1) - 2)}

"The joining of systems to form a new one" (E. JANTSCH, 1982, p.346).

Endosymbiosis seems to be a fundamental evolutive feature through the acquisition of **complexity** by the complementary union of different **modules**.

E. JANTSCH states: "In endosymbiosis, ... the original **semantic** (sic) **levels** are usually maintained, giving rise to **multilevel** systems in which each **level** functions in a **semiautonomous** way. This guarantees a substantial **gain** in **complexity**" (Ibid).

This type of **process** can be observed at every **level** of **organization** in **living systems**. L. MARGULIS established in the mid-sixties the endosymbiotic origin of eucaryotic cells.

According to JANTSCH, it may even be possible that: "... ideas may enter the endosymbiosis to form **paradigms**, **paradigms** to form world views, and so forth" (Ibid).

1082

ENERGETIC BALANCE ¹⁾

G. BATESON has observed that energy expenditure of a **living system** can be an inverse **function** of its energy **inputs**.

He gives the following significant examples: "If you kick a stone, it moves with energy which it got from your kick. If you kick a dog, it moves with the energy it got from its **metabo-**

lism. An amoeba will, for a considerable period of time, move *more* when it is hungry. Its energy expenditure is an inverse **function** of energy **input**".

In P. VENDRYES terms, the system is able to counteract environmental **perturbations** if it possesses available and qualitatively adequate **reserves** (1942).

However, these **reserves**, when used, must be regenerated in due time by sufficient **inputs**.

1083

ENERGETICS ⁵⁾

The physics of **energy** and its **transformations**.

This term now quite in disuse was proposed in the 19th century by W. RANKINE, but replaced by "**thermodynamics**", introduced by lord KELVIN. This change may be considered as infortunate, since "energetics" was less restrictive and more appropriate to a general science of **energy**.

1084

ENERGY ¹⁾

The power to bring about some **transformation**.

This definition is merely for general practical use. In fact, as G.L. FARRE states: "No one really knows what energy actually is. We only observe its **transformations**, which are represented by the laws of science, and marked by the eventual traces they leave...Whatever energy is, it is at the very least the dynamical principle of the observable **universe**" (1998b, p. 262).

We do not observe energy directly, but merely through **events**, i.e. **changes** produced by it. FARRE also notes that energy manifests itself under different aspects at different **levels** of the observable world, from the quanta to the gravitational level (Ibid).

Energy is quite an abstract concept, that we extract from perceived manifestations of **change** as for example electric, mechanical or thermic transfers, that may become or made visible through material **phenomena**.

It seems to be part of our very basic perceptive and mental **structure**, and inseparable from these other very basic notions: **time**, **space** and **matter**.

This may explain why the global concept of energy emerged only slowly, through the works of the 19th and 20th centuries thermodynamicists and of EINSTEIN.

According to D. SEIDEN and H. SABELLI: "Flowing in the direction of **time**, energy as well as **change** embodies a form, namely **unidimensional asymmetry**" or: "**Process theory** identifies... cosmic **asymmetry** as the temporal **flow** of energy" (1992, p.721).

1085

ENERGY BUDGET ¹⁾²⁾⁴⁾

The inflow of energy needed by a system for its subsistence.

Any **ecosystem**, biological or human social system depends on energy **inputs** for its **maintenance** and **dynamic stability** (J.P. COLLINS et al, 2000, p. 416-25).

Stable energy **inputs** allow for stable energy **dissipation** by the system (Prigogine's Principle of **minimum entropy production**).

Any system starved of energy **inputs** and devoid of compensatory available **reserves** is doomed to rapid destruction.

On the contrary when a system increases its energy **inputs**, it becomes able to create more complex **processes** and **structures** through a more active energy **dissipation** and the consequent **emergence process**.

Such a **phenomenon** has dominated the evolution of mankind, particularly since the beginning of the 19th Century, to date.

However, in fact the **transformation** has been obtained through an enormous subsidy of non-renewable fossil energy supply. Should this supply dwindle in the future, subsequent **growth** and **dynamic stability** will depend on its sufficient replacement by a renewable supply, i.e. basically solar energy and its derived forms.

1086

ENERGY (Downgrading) ¹⁾

As noted by J.de ROSNAY, at first sight, "there seems to exist a contradiction between the 1st. and the 2nd. Principle (of **thermodynamics**): the first one says that heat and energy are two magnitudes of the same kind; the other that they are not, since energy downgrades **irreversibly** into an "inferior", less "noble", or of "lesser quality" energy: heat. The riddle is solved by the statistical theory. Heat is really energy. More precisely, it is a kinetic energy, resulting from the individual velocities of the molecules of a gas or from atomic vibration in solids. but, under its "heat" form, this energy is reduced to a maximally disordered **state** in which each individual movement becomes soon or later neutralized by the law of great numbers.

"Thus potential energy is ordered energy and heat is disordered energy"...

"In the first case the global movement of the molecules (in a gas for example) is apt to produce some work (move a piston). In the other case, there is an inefficient agitation "on the spot" and in every direction at the same time: the energy is there, but cannot be used" (1975, p.137).

In this last form it is sometimes called "energy".

Heat is thus dispersed energy, reduced to molecular agitation. Everyday experience proves that any use of energy finally produces heat, without exception. **Entropy** is a measure of this downgrading.

1087

ENERGY (Embodied) ¹⁾

The total **energy** that has been required – directly or indirectly – to construct a system or to produce a product.

This is a very intriguing concept. Any system, natural or constructed, is somehow a totalization of residue of former energy uses. R. CONSTANZA, (quoted by R.N. ADAMS) gives the following example: "... the energy embodied in an automobile includes the energy consumed directly in the manufacturing plant plus all the energy consumed indirectly to produce the other **inputs** to auto manufacturing... etc." (CONSTANZA, 1981, p.119).

The real final energy balance and rentability of nuclear power has also been questioned, because of the similar omission of "upstream" energy **costs**.

Even the energy consumed by the **process** of scientific and technical research should be accounted for in the global energy **cost** of products.

D. PIMENTEL, who applied energy accounting to agriculture, showed that real energy **costs** of industrial agriculture are rarely if ever recuperated in the energy value of the final products (1977).

Still another aspect is the omission in the final **cost** of replacing lost patrimonial value, as is the case, for instance of the use of non-replanted felled forests.

As to natural systems, the appearance of the **GAIA** concept shows a nascent conscience of the embodied energy value in natural **environments**, as a long term totalization during the whole **process of evolution** towards **complexity**.

1088

ENERGY FLOW ^{1) – 5)}

"The one way passage (**transfer**) of energy through an **ecosystem**, including the way in which energy is converted and used at each trophic (food) **level**..." (UNESCO – UNEP Glossary, 1983, p.11).

1089

ENERGY FLOW (Principle of maximum) ^{1) – 2)}

"The physical **configurations** of the **organism** and the organic world as a **whole** are determined by the requirement of maximizing the **rate** of energy exchanges within the **organ-**

isms and between them" (N. RASHEVSKY, 1956, p.124).

This principle was originally stated by A. LOTKA in 1924, (1956, p.357).

LOTKA elaborates the concept of "coupled energy transformers". He explains that two or more systems, coupled "in cascade" become able to use a whole **range** of *differences* of energetic **levels** quite better than anyone of them separately, in view that each one, due to its proper characteristics, is only able to use a certain specific type of energy at a specific **level**.

According to LOTKA, the green plants and the animals, being globally coupled, constitute a kind of "**world engine**" *globally* able to use a greater part of the sun's **energy**. The price that they pay for this is that the global engine "...spends all its work feeding itself and keeping itself in repair, so that no balance is left over for any imaginable residual purpose. Still it accomplishes one very remarkable thing; it *improves* itself at it goes along, if we may employ this term to describe those progressive **changes** in its composition and construction which constitute the **evolution** of the system" (p.335).

The "world engine" thus progresses towards *global efficiency*, which, by the way, makes it altogether an **entropy** accelerator, *similarly global*. Such a **model** offers, somewhat unexpectedly, a base for the idea that the planet constitutes a coherent global system, at the same time evolutive and **autogenetic**, in conformity with J. LOVELOCK's "**GAIA**" concept.

This is confirmed by R. MARGALEF's discovery that the flow of energy is from the less to the more organized systems in a global **ecosystem** (1982)

→ **Saint Matthew's Principle**

Finally, LOTKA's law has been wholly confirmed by PRIGOGINE's **thermodynamics of systems faraway from equilibrium**, in which emergent **complexity** may appear through **dissipative transformation** of energy into **structures**, particularly in those systems already most highly organized.

PRIGOGINE and ALLEN moreover consider that LOTKA's law "corresponds to the **evolution** of western societies in a situation where **energy resource** stocks were not a limiting factor"... As a result "LOTKA's law finds its natural interpretation in a succession of **structural instabilities** under these conditions" (1978, p.76-7).

However, excessive energy **flows**, in particular sudden **wave** shocks, can become destructive. ODUM gives as examples the melting of insulation wires or the violent release of strong thermal winds during a forest fire.

1090

ENERGY LAW (Darwin – Lotka)^{1) – 2)}

"Whenever it is necessary to transform and restore the greatest amount of energy at the fastest possible rate, 50 percent of it must go into the drain" (as stated by H.T. ODUM, 1971, p.31).

LOTKA himself wrote: "The discharge of a portion of the energy from the **source** into a **sink** is practised, not designedly because any useful **purpose** is served thereby, but unavoidably because, in the case of all forms of heat engines, the **second law of thermodynamics** inexorably demands this payment of a tax to nature, as it were" (p.326).

Of course, biological **organisms**, and still more so human societies are "forms of heat engines"... and must pay the tax.

1091

ENERGY NETWORK²⁾

The pathways and **circuits** covered by an **energy flow** in a system or **set** of systems.

The **concept** has been introduced by H. ODUM (1971).

As explained earlier by A. LOTKA high quality energy entering a **set** of interconnected systems becomes degraded by **stages**, while part of it may be recycled in some sections. As stated by R.N. ADAMS: "There is an **energy cost** of every **activity**, act, and **event**" (1988, p.35).

ODUM proposed "energy network diagrams" as a **representation** of energy networks: "**Flows** of energy move from the **sources**, usually drawn on the left along pathways lines to the right. We refer to these **flows** as moving from upstream to downstream when they move from **source** towards **sink**. In **energy circuit language**, the simple arrow is used to indicate the direction of the driving force". ODUM created a number of graphic **symbols** to describe the various **transformations** incurred by the **energy flow**: **Source**, passive **storage**, heat **sink**, potential generating work, cycling **receptor** (or, **module**), **work gate**, **self maintenance**, **switch**, **transaction** constant, **gain amplifier**, **active impedance**, one way valve and **adding junction** (p.37-38).

1092

ENERGY PULSE²⁾

The propagation sequence of an **energy input** from one **compartment** or **subsystem** to another, throughout the whole system.

H. ODUM who introduces the concept writes: "If the **energy** arrives with repeating pulses, a train of transient peaks keeps repeating. Depending on the resistances, capacitances, and **time delays** introduced, the system's pulse

may be **damped** out downstreams or reinforced to produce an **oscillation**. Thus, **populations**, economies, and radio **networks** may oscillate or be smoothed" (1971, p.261).

1093

ENFOLDMENT¹⁾

The inclusion of local **order** within global **order**.

The **concept** has been proposed by D. BOHM, who also uses the term "implicate **order**". It is related to his concept of **holonomy**, i.e. the law of the **whole** (1980, p.156).

Through the property of **self-similarity**, local **order** may reflect global **order** and vice-versa. This is the basic property of **holography**.

D. BOHM and F.D. PEAT write: "This global property of enfoldment of **information** and detail has something in common with both **fractal** and **FOURIER orders**" (1987, p.175).

We should also mention **WEIERSTRASS' re-normalization** equation.

Enfolded order can however be unfolded, by describing the **interactions** between aspects in the system (p.156 and 184).

1094

ENGRAM⁵⁾

1) Trace left in the **brain** by a past **event** (French Robert Dictionary)

2) The neurological **change** in the **brain** that occurs during the **process** of memory creation (J. BRYANT, 1991, p. 114)

The American Heritage Dictionary (Amer. Her. Dict.) defines the engram as "a persistent protoplasmic alteration hypothesized to occur on **stimulation** of living **neural** tissue and to account for **memory**"

Interestingly BRYANT comments that: "...since the histological details of most human brains vary among one another in many ways which are not due to **learning**, it seems likely that the engram which represents a certain bit of **information** in one individual may be quite different from the engram that represents the same **bit** of information in some other individual. Thus if two people have knowledge of the "same **fact**", we should not therefore assume that they possess identical engrams, but rather that there exists a specific **correspondence** between certain **neural networks** of the two brains" (p. 114) Let us hope so!

→ **Memory; Perception; Representation**

1095

ENRICHMENT⁵⁾

In an ecological sense, an excessive increase of some **input** in an **ecosystem**.

According to S. REICE, "Enrichment **events** often constitute **disturbances**... (or) can be viewed as the indirect cause of the **disturbance**" (1994, p.428).

This is for example the case of a lake's eutrophication due to a considerable surfeit of nutrients.

More generally, in any system the excessive supply of some **input** creates a disbalance conducive to **disturbance**.

1096

ENTAILMENT³⁾

1. A necessary and predetermined **order** of succession in logical argument or between **facts**.

2. "A necessarily included (or implied) accompaniment, such as an antecedent, constituent, adjunct or consequent" (D. Mc NEIL, 1995, pers. comm.).

Entailment, as first defined, is closely related to **determinism**, but does not have an absolute predictive value in complex **situations**.

Mc NEIL's definition emphasizes a more **syn-tactic** viewpoint, not necessarily opposed to the first one.

1097

ENTAILMENT MESH¹⁾³⁾

The internal **structure** of a field of **knowledge**.

According to G. PASK, as quoted by R. GLANVILLE in "Beyond the **boundaries**" (1979), this type of structure is circular. It is however not static. For example, EINSTEIN's relativity embeds Newtonian mechanics.

Knowledge is acquired and becomes structured within such entailment meshes. Even something as basic as **learning** to walk implies the structuration of an entailment mesh (R. GLANVILLE, 1978 a)

1098

ENTANGLEMENT¹⁾²⁾

A mode of **interconnections** between **elements** which is confusing.

Entangled **relationships** are difficult to understand. They may even imply functional contradictions or **incompatibilities**.

Entanglement **situations** may appear for example, in political and administrative systems when the proliferation of subsystems and **sub-structures** is not adequately controlled. In such cases the **efficiency** of the system as a whole may be seriously impaired and the system could even be self-destroying

1099

ENTELECHY^{3) – 5)}

A supposed **vital force** driving a **living system** toward self-fulfillment.

Originally, for ARISTOTLE, entelechy was the mode of being of the completely realized **structure** of something, i.e. the result of the actualization of its potentialities.

This quite abstract notion was re-introduced as a kind of conceptual crutch by H. DRIESCH, unable to otherways understand some biological experiments, as for instance that a sea urchin egg, segmented in two parts, was able to produce two perfectly formed urchins.

DRIESCH vitalism was never admitted by many biologists and a protracted debate between **vitalists** and **mechanicists** ensued. Finally, it became apparent to L.von BERTALANFY and J. WOODGER, creators of **organismic** biology, that the conceptual deficit corresponded to our lack of good **models** of organized **complexity**.

Overtones of Aristotle's entelechy seem perceptible also in some very recent physical theories, as D. BOHM's **implicate order**, and the concept of decoherence in microphysics, and Prigogine's **emergence** through **dissipative structuration**.

In metaphorical terms the "real" world is starting to appear somewhat similar to the fading smile of Lewis Carroll's Cheshire cat.

In the same vein, F. CAPRA refers himself to Goethe: "Each creature is but a patterned gradation (Schaffierung) of one great harmonious whole" (1997, p. 21)

Capra also notes further on that the classical aristotelian concept of entelechy "as a **process** of self-regulation", was "postulated by DRIESCH (as) a separate entity, acting on the physical system without being part of it" (ibid. p. 26)

This typically mechanistic view, combined with the need for a "deus ex-machina" was later on rejected by **organismic biology**, which somehow went back to Aristotle's concept.

1100

ENTHALPY⁵⁾

"A measure of the total thermal **energy**, including the **changes** of **states**, included into a kilo or a mole of **matter**" (D. DUBOIS, 1987, p.62).

DUBOIS writes: "...thermal **energy** is the only form of **energy**, whose energetic value remains absolutely constant during its **flow** by conduction in **stationary regime**. ...thermal **energy** is the only one which is totally retained through a heat transfer because...it is the lowest of all possible forms"(p.64).

In some chemical reactions, energy in the form of heat is released (exothermic reactions, f. ex. **explosive processes**). In others, so-called "**activation energy**" must be added to initiate and sustain the reaction (endothermic reaction).

G. DYER emphasizes the role of **catalysts** in this last type of reactions: "**Catalysts** work in various ways, but their purpose is always the same - to reduce the **activation energy**. Using

a catalyst will allow a reaction to proceed with lower **energy input**" (1996, p.47).

DYER uses the enthalpy and **catalysts models** as **metaphors** for psychological reactions in small **design groups**, whose **dynamics** must be activated and can be much favored by a **catalyst**, in this case a spirit of free exchange and collaboration (ibid).

The considerable increase of enthalpy in man-managed physico-chemical systems during the last 150 years is closely related to the sociological **chain reactions** that we witnessed during this century.

→ **Entropy production (Theorem of)**

1101

ENTIFICATION¹⁾

"The discontinuous "moment" when a **nonlinearity** comes into being, as an empirically traceable **space-time entity**, defined by the circular relations of its atomisms" (R. SWENSON, 1989, p.189).

This concept is a dynamic derivate of R.W. GERARD's "entitiation" (see hereafter).

By "atomisms" SWENSON means "**elements**" or "**components**". As to the "circular relations", we may suppose that it refers to the **organization closure** that must coalesce at that critical moment.

Entification is an **emergence phenomenon**. According to F. ROBB: "From the macroscopic view it represents the coming into being of a new "entity", and from the microscopic view it is seen as a new **environment** with a new **set** of **constraints**" (1990, p.391).

1102

ENTITATION¹⁾

"The recognition or discovery of an entity that can be studied as a system" (after R.W. GERARD, 1964, p.120).

For GERARD, a system is "an **element** sufficiently **whole** and independent and internally organized to deserve separate study". Moreover he writes: "This qualitative recognition of the important systems... is far more important than their **measurement**. Entitation must precede quantitation; only when the right things have been found to measure are **measurements worthwhile**" (ibid).

For R. THOM any entity is *recognized* through its **form**. He adds however that "... for living beings, **form** is not limited to external **form**... it is also the **form** of all the internal **organs**... an internal **form** that somehow prolongs the external one". He observes that internal **form** "in embryology, is constructed continuously from the external **form**" (1991, p.115).

1103

ENTITY¹⁾²⁾³⁾

A discreet unit

In English (and in Spanish) this word corresponds generally to a well defined **object** or **organization**, clearly distinguished from any other. Its **meaning** is thus close to that of system.

In French and German (Dasein) it has a more abstract and even **ontological** meaning, closely related to existence in itself.

Of course, any pinpointing of an "entity" is made by an **observer** within specific conditions and **intentionality**

→ **Entification; Entitation**

1104

ENTITY (Reference)

→ **Stigmergy**

1105

ENTRAINMENT^{2) - 5)}

"A locking together of **frequencies**" (A.T. WINFREE, 1980, p.114).

This **phenomenon** corresponds to the **behavior** of two or more **oscillators** in **process** of **coupling**. The **oscillators** may be electrical, physical (clocks), chemical (malonic acid reaction), biological (organic functions) or social (**dictyostelium discoideum** congregation, fireflies forming **swarms** and, probably, homogenization of some characteristics in human **groups**).

Entrainment is thus a **process** of **self-organization**. It can be **topologically** modeled (R.A. ABRAHAM & C.D. SHAW, 1988, p.560).

WINFREE explains that entrainment does not necessarily implies "... a stable **relationship**, let alone... **synchrony**" (ibid).

Entrainment is not possible "... if the **periods** are too unequal or the mutual influence is too faint" (ibid).

Mutual influence obviously implies mutual **perception** through some mode of **communication**. In S. STROGATZ and I. STEWART words: "If their **interconnections** are too weak, the **oscillators** will be unable to achieve **synchrony**" (or an existing **synchrony** will be destroyed) (1993). This was already shown by Chr. HUYGHENS, with his classical experiment on **synchronic correlation** of two clocks.

For an experimental device that demonstrates entrainment see W. GARVER and F. MOSS "electronic fireflies" (1993, p.94).

1106

ENTRANCE¹⁾

Any opening or **gate** in the **boundary** or a system that allows **inputs** in a selective way.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

In French, the word "entrée" is unfortunately very generally also used in the meaning of **input**. This obscures the meaning of "entrée" as an opening in the **boundary**. The same confusion is also creeping into Spanish. The same problem exists with "sortie", i.e. **exit**, but also **output**.

→ Entry

1107

ENTROPIC DRIFT^{1) - 2)}

A natural tendency in complexes of associated systems to the compensation of unbalances. (after St. BEER, 1968, p.355).

For example, in an **ecosystem**, the unordinate **growth** of one species becomes quickly checked by some destructive countervailing factor. St. BEER gives the example of the potential fantastic propagation of aphids which, if unchecked, would produce 822.000.000 tons of aphids in one summer (New York Academy of Sciences). However, this "... does not happen... the **variety** generation that is the procreation power of the aphids is absorbed within the **ecosystem** by **homeostasis**". Even so, and notwithstanding the non-existence of any "controller", "... the **process** of massive retrenchment of an animal **population** (does not) misfire to the extent of annihilating the entire species" (ibid).

In effect, entropic drift tends to maintain global **homeostasis**, i.e. is a factor of **order**.

Unfortunately, man seems to have the power to check this re-equilibration **process**, and at least until now, seems also to be unaware of the kind of potentially **runaway situations** this may **trigger**.

1108

ENTROPY^{1) - 5)}

1) "The amount of **disorder** in a system, which by the **2nd law of thermodynamics** will tend to increase unless the system is open to receive **negentropy**, which is **information**" (J.Z. YOUNG, 1978, p.292).

2) "Abstract quantity, which characterizes the **disorder** of positions, velocities or other **variables** of particles in a large system" (R. FIVAZ, 1991, p.31).

We may distinguish statistical entropy, which measures disordered **dispersion**, and **thermodynamic** entropy which corresponds to the degree of degradation of **energy**, i.e. measures its uselessness to produce some work.

The maximum entropy in a system corresponds to the complete disappearance of **energy** potentials, i.e. the final disappearance of any **order**, in which case the system ceases to be a system.

YOUNG's assimilation of **negentropy** with **information** is not universally accepted. The **negentropy** concept itself has been much debated as to its real significance.

R. FIVAZ explains: "... (entropy) is measured by the logarithm of the number of distinct **configurations** realized by permutations between all possible values of these **variables**" (ibid).

Entropy is basically a *relational* notion which reflects the **irreversible** degradation of **energy**, through its **transformations**. The tendency of entropy is to increase monotonically and to reach a maximum as the (ideally **isolated**) **system** reaches its final **equilibrium** state.

I. PRIGOGINE writes: "As is well-known the basic importance of the **second law (of thermodynamics)** in the context of physical **evolution** was clearly recognized by CLAUSIUS who introduced the term "entropy" which in Greek means "*evolution*" (1973, p.561).

Entropy is originally a **thermodynamic** notion. It may be transposed to **cybernetics** and **systemics**. In this case, according to J.van GIGCH, it: "... refers to the amount of **variety** in a system, where **variety** can be interpreted as the amount of **uncertainty** prevailing in a **choice situation** with many alternatives" (1978, p.41).

In order to avoid **ambiguity**, let us remember however that:

1) **variety**, in a **structured system**, is obtained by defining **constraints** upon the **relationships** between **elements**. In this way a finite number of **choices** are possible.

2) excessive or total **constraints** reduce or destroy **variety**, as they diminish or suppress the number of **autonomous subsystems**. The number of possible **choices** tends to nil.

3) no **constraints** at all means total indefiniteness and thus the impossibility of any significant **choice**. Only in cases approaching this limit should **variety** be interpreted as entropy.

1109

ENTROPY: its interpretations¹⁾

Entropy has been interpreted in quite various ways. Already BOLTZMANN, proposed in 1870 a statistical interpretation based on the collective **behavior** of the numerous molecules in a gas. In this view increasing entropy - at least in an **isolated system** - indicates a trend toward an ever increasing and irreversible **disorder** in the system, i.e. the disappearance of all local differences in the **distribution** of the **elements**. This implies the disappearance of internal **organization**.

According to J.de ROSNAY: "The notion of entropy is extremely abstract and thus very difficult to imagine. However some do consider it as intuitive. They only refer themselves mentally to real **situations** like **disorder**, squandering, loss of **time** or **information**. but, how can one really imagine a **degraded energy**? And why such a **hierarchy** of **energies** and this degradation?...

"Thanks to the mathematical relation between **disorder** and probability, it is possible to speak of an **evolution** towards a growing entropy through one or the other of the following expressions: "When left alone, an **isolated system** tends toward a state of maximum **disorder**" or, "When left alone, an **isolated system** tends towards a **state** of greater probability".

"These equivalent expressions may be resumed in the following table:

Potential energy .	— entropy
Ordered energy .	— disordered energy (heat)
"Noble" energy ...	— degraded energy (heat)
Order ...	— disorder
Improbability...	— probability

"The notion of entropy and the one of **irreversibility**, coming from the 2nd principle, had consequences of enormous impact on our world view. By breaking the vicious circle of repetitiveness in which the ancients had enclosed themselves and by opposing to biological **evolution**, creator of **order** and **organization**, the notion of entropy did indirectly open the road to a philosophy of becoming and progress" (1975, p.137).

However, immediately thereafter ROSNAY points out that: "The image of the inexorable death of the universe, suggested by the 2nd. principle, did profoundly influence our philosophy, our morals, our worldview and even our art".

In fact, as expressed by J.L. ESPOSITO entropy can be considered as the *subjective* view of systems as considered by an **observer** and "... would be a measure of the degree of our **knowledge** of them" (1975, p.136). This is of course an extreme opinion, which nearly amounts to negate any objective reality to entropy.

Quoting L. BRILLOUIN (1959), de ROSNAY asks: "How is it possible to understand life when the whole world is directed by a law like the **2nd. principle of thermodynamics**, which points towards death and annihilation" (1971, p.138).

While these questions are far from being thoroughly answered, some scientists at least have brought forth elements of solution (SZILARD, BRILLOUIN himself, PRIGOGINE), which one may resume - by excessive simplification, admittedly - saying that a compensation seems to exist to entropic disorganization, and that it is precisely more **organization**, locally concentrated, and progressing with **time**. But the price is always paid: This **organization** seems to grow in proportion to a parallel *acceleration* of entropy's increase.

Another viewpoint is developed by C. JOSLYN, who distinguishes **thermodynamic** entropy (*S*) and statistical entropy (*H*). He writes: "**Thermodynamic** entropy is a property of cer-

tain kinds of real systems: **thermodynamic** systems. **Thermodynamic** entropy is a measured property of such systems, and is understood in a differential relation to other quantities, such as heat, work, and temperature, which are also measured on **thermodynamic** systems.

"**Thermodynamic** entropy is thus a "content-full" **concept** specific to **thermodynamic** systems. The **semantics** of **thermodynamic** entropy is necessarily deeply embedded within the body of thermal physics and it must be interpreted in the context of all of **thermodynamics**..."

One wonders however: Are there "real" systems which are not thermodynamic systems?

JOSLYN pursues: "But unlike **thermodynamic** entropy, statistical entropy is a property of a probability **distribution**, not a real system. Statistical entropy is calculated from the numerical properties of this **distribution**... Statistical entropy is thus essentially a "context-free" **concept**. Whatever interpretation of the p_i (i.e. probability **distribution**) we make, need only adhere to the axioms of probability theory" (1991, p.622-3).

1110

ENTROPY (Negative)^{1) - 5)}

"A measure of improbability or of **information**" (L.von BERTALANFFY, 1956, p.5).

BERTALANFFY comments: "... entropy is a measure of **disorder**; hence negative entropy or **information** is a measure of **order** or of **organization** since the latter, compared to distribution at **random**, is an improbable **state**. In this way **information theory** comes close to the theory of **open systems**, which may increase in **order** and **organization**, or show negative entropy. But negative entropy can be considered a measure of **decisions**, taken out of equally probable ones" (p.5).

R. ROSEN points out: "... it was considered a great insight when SCHRÖDINGER characterized the obvious persistence of spatial order in biological **organisms** as arising from their feeding on "negative entropy" (SCHRÖDINGER, 1945, quoted in ROSEN, 1960, p.267).

It must be pointed out that the concept of negative entropy has received various, not universally accepted interpretations (see hereafter).

1111

ENTROPY PRODUCTION^{1) - 4)}

It is generally assumed that "**order**" corresponds to a "diminution of entropy", through the incorporation of material, energetic and/or informative **inputs** into a system. While this may be true in the sense that the system may thus maintain its internal **organization** or even increase it by **dissipative structuration**, **global** entropy is effectively increasing.

R. SWENSON accordingly stated that: "**Order** produces entropy faster than **disorder**" (1989, p.125). Or better, more **order** produces entropy faster than less **order**.

F. ROBB explains it in the following way: "Entropy production is much accelerated when a new higher **order** entity emerges from lower **order** interaction, and, where conditions in the **field** permit. This is the preferred route to be selected for the maximization of the **rate** of entropy production. The **emergence** of a new entity **constraints** the microscopic **interactions** in the **field** whence it emerged. For a new entity of a higher **order** to emerge there must be (1) circular relations of **mutual causal processes**, (2) enough free **energy** to sustain these **processes**, and (3) the conditions in the arena of the microscopic **interactions**, its **configuration** and the presence of adjacent higher **order** entities, must allow such **processes** to proceed: there must be room for **emergence**" (1993, p.1).

If these conditions exist: "... then the emergent **entity** which can produce the maximum entropy is preferentially selected from all others afforded by the **constraints** present in the **field**" (1990, p.392).

This is perfectly coherent with PRIGOGINE's **thermodynamics of open systems faraway from equilibrium**.

These concepts seem to be the basic explicative key to human **evolution** if one considers the two following complementary aspects:

- 1) Since the appearance of man, evermore complex social forms of **organization** did emerge and this trend is constantly accelerating since about 200 years ago;
- 2) This **phenomenon** is matched at the same time by an exponentially growing use of **energy** and an also accelerating global entropization of the planetary **environment**.

One wonders if this is a **runaway process** and where it will lead us: to global disaster or to a **Meta-System Transition** (TURCHIN)?

1112

ENTROPY PRODUCTION in a system^{1) - 4) - 5)}

E. LASZLO writes: "The PRIGOGINE equation states that entropy change in a system is governed by the relative values of the terms in the equation $dS = dS_e + dS_i$, where dS_i denotes entropy change through the **input** and dS_e entropy produced through **irreversible processes** within the system. Whereas dS_e is always positive, dS_i may be positive as well as negative. If it is negative, the **dissipation function** of a system ($P = d_e/d_i$) is negative, i.e. is greater than 0. In this case the system decreases its net entropy or, correspondingly, gathers **information**" (1974, p.221).

There is thus a **thermodynamic** way to **self-organization** for **open systems**.

D. HERSHEY developed the concept of **Excess Entropy Production**. "For the living system, Excess Entropy Production diminishes with age and nears zero in the vicinity of death. For the aging corporation, a diminishing Excess Entropy Production track can signal stagnation, a general decline in organizational vitality" (1991, p.126).

This somewhat esoteric view implies that a diminishing rate of **energy** degradation for **adaptive activity** (for example **learning** capacity, organizational innovation, **creativity**) signals the beginning of **ageing** and **sclerosis** in systems.

1113

ENTROPY PRODUCTION in STEADY STATE^{2) - 5)}

When a system reaches its **steady state**, the entropy production becomes stabilized at a corresponding minimum (**Principle of PRIGOGINE**) and the **level** of entropy becomes constant. This is possible only because the system is able to transfer to its **environment** the entropy that it permanently produces.

If some **disturbance** takes place, due to a small increase or decrease of some **gradient**, the **flow** will automatically be modified in such a way as to nullify the **effects** of the **disturbance** and maintain the **steady state**.

This condition, proper to the systems in a **steady state**, may be compared with the **Principle of LE CHATELIER** in physical and chemical systems.

1114

ENTROPY PRODUCTION (Theorem of minimum)^{1) - 5)}

I. PRIGOGINE showed (1945) that a **system close to equilibrium** and in a sufficiently **stable environment**, evolves toward a **steady state** that minimizes the **dissipation of energy**.

This applies to **open systems close to equilibrium** and goes a step further than the classical law of **irreversible** increase of **entropy** in **isolated systems**.

It also seems to be the dynamic version of the **LE CHATELIER principle** of action and reaction for simple systems in **static equilibrium**.

In order to maintain their **equilibrium**, **open systems** of this type must constantly export **entropy** to their **environment**.

Minimum entropy production is corresponded by minimum **dissipation of energy**. In PRIGOGINE words: "The theorem of minimum entropy production expresses a kind of 'inertial' property of **nonequilibrium systems**. When given **boundary conditions** prevent the system from reaching thermodynamic **equilibrium** (i.e. zero entropy production) the system settles down in the **state** of least **dissipation**" (1980, p.88).

This is a stationary **state**. It allows the maintenance of an organized **state** in **nonequilibrium** conditions (but *close* to **equilibrium**, i.e. **homeostatic**, or **homeorhetic**).

Later on P. GLANSDORFF and I. PRIGOGINE considered and resolved the case of dynamic **systems far-from-equilibrium**, which are not any more able to maintain themselves in their former **steady state** and may jump to other **states** through **bifurcations**. In such a case: "... the **thermodynamic behavior** could be quite different, in fact, even opposite to that indicated by the theorem of minimum entropy production" (PRIGOGINE, 1978, p.2-7).

1115

ENTROPY (Social)

→ Social Entropy

1116

ENTROPY versus Improbability^{1) - 3)}

The apparently impossibility of any type of structuring and ordering **evolution** that seemed to result from the **2nd. principle of thermodynamics**, anguished many scientists during the first fifty years of the 20th century, as for example the French biologist P. LECOMTE DU NOUY. Biologists were the most desperate. H. SIMON, citing an article by H. JACOBSON, published as late as 1955, (JACOBSON, 1955) comments: "The essential idea in JACOBSON's **models** is that the expected **time** required for the system to reach a particular **state** is inversely proportional to the probability of the **state** - hence increases exponentially with the amount of **information (negentropy)** of the **state**."

"Following this line of argument, but not introducing the notion of **levels** and stable sub-assemblies, JACOBSON arrived at estimates of the **time** required for **evolution** so large as to make the event rather improbable. Our analysis carried through in the same way, but with attention to the **stable intermediate forms**, produces very much smaller estimates" (see the "**Hora and Tempus parable**").

SIMON demonstrated the possibility of the progressive **emergence of organization step by step**, through successive **levels of accumulation**.

This **concept** must be connected:

1) with the appearance of **dissipative structures** in systems overfed with an excessive quantity of **energy**, which push them through **instability thresholds**.

2) with the **concept of negentropy**, which, in the words of SIMON, "can be interpreted as the logarithm of the reciprocal of the probability - the "improbability".

3) the **understanding** that higher **complexity** in systems implies a higher **level** of entropy production.

1117

ENTROPY-VALUE RELATION⁵⁾

According to N. GEORGESCU-ROEGEN, "low entropy... is a *necessary* condition for a thing of value" (1971, p.282).

This is the viewpoint of an economist who equates value with usefulness. Value in this sense is necessarily an entropy based **concept** since low entropy is associated with **order** (a potential for use) or **organization** (a potential for efficient **action**), while high entropy implies uselessness.

1118

ENTRY^{1) - 5)}

The inclusion of some item in a **store**, a list or an account.

This is *not* a satisfactory systemic term in English. It is included only because in the French literature "entrée" is frequently used as a translation for "**input**", not satisfactory either.

"Entrée" means properly a "Gate" in a **boundary**.

1119

ENVELOPE²⁾

The external surface that limits the volume of **space** occupied by a system.

Differently, in mathematical terms, an envelope is a curve that is tangential to every member of a family of lines or curves.

This abstract concept (still defined in different terms by R. ACKOFF and EMERY, 1972, p.17) has been used by F. ZWICKY to describe higher **levels of integration of processes** at lower **levels (Morphogenetic worldview, 1971)**, and F. MEYER in a dynamic **meaning**, to describe acceleration in general **evolution** (1954).

In a more physical sense, close to "boundary", **composite systems**, which are continuously shifting in their composition and **form**, do not have any permanent envelope. It is also impossible in most cases, to describe an envelope for an **ecosystem** or a **human organization**.

Only quite strongly **integrated systems** may be said to have a well definable envelope, as for example the skin of an animal.

The envelope is at the same **time** a **boundary** that separates the system from its **environment** and an **interface** through which exchanges with the same (**inputs, outputs**) take place. It is sometimes **fractalized**, which makes it difficult to define its **limits**.

1120

ENVIRONMENT¹⁾

1. "The **context** in which a system exists" (1973, p.86).

B. BANATHY states: "It is composed of all the things that surround the system, and it includes everything that may affect the system and that may be affected by the system" (Ibid).

Of course, the whole universe is the environment of any system. Practically we must thus define in a more restricted way the environment of the system as those **parts** of the general environment that interact with it more or less strongly and/or permanently. However, there is a snag (or two):

a - Two different **observers** may very well have different **descriptions** of the system's environment (pursuing either the same- or a different **goal**)

b - There is never any absolute certainty that the **observer** did not forget, or be unable to register some important **part** of the environment.

An incorrect or incomplete evaluation of the environment is the main cause of most of the technological and social catastrophes engineered nowadays by ill-advised planners.

2. "Those **variables** whose **changes** affect the **organism** (system) and those **variables** which are changed by the **organism's** (systems) **behavior** (W.R. ASHBY, 1960, p.36).

A more or less equivalent definition by S. KATZ is: "... everything the nervous system may use as a source of **knowledge**" (1976, p.45).

ASHBY states: "It is thus defined in a purely functional, not a material sense" (Ibid). There are reciprocal **feedbacks** between the environment and the system. ASHBY cites STARLING, who wrote: "**Organism** and environment form a **whole** and must be viewed as such" (1960, p. 38). Unfortunately, this necessity is very frequently ignored, even by high level systems designers of the most various kinds: physicians, engineers, economists, agronomists, etc.

In the words of M. DODDS and G. JAROS "... the environment is not a neutral laboratory, but a **stakeholder** with its own needs" (pers. comm.).

This very serious problem is related to J. FOURASTIE's "Ignorance of ignorance" or to G.de ZEEUW's "**invisibility**": a part of the significant environment is not perceived.

3. "For a given system, the environment is the **set** of all **objects** a **change** in whose attributes affect the system and also those **objects** whose attributes are changed by the **behavior** of the system" (A.D. HALL & F.E. FAGEN, 1956, p.20).

While this very old (1956) definition looks quite rigid, HALL and FAGEN have it perfectly clear that "The statement above invites the natural question of when an **object** belongs to a system and when it belongs to the environment; for if an **object** reacts with a system in the way described above should it not be considered a **part** of the system? The answer is by no means definite. In a sense, a system togeth-

er with its environment makes up the **universe** of all things of interest in a given **context**. Sub-division of this **universe** into two **sets**, system and environment, can be done in many ways which are in fact quite arbitrary" (Ibid).

These comments are allowable, but their importance should not be over-emphasized: In most practical cases, it is easy to distinguish the system within its environment, mostly so when it is a strongly **integrated system**. This being the case, the only doubt is about some border **elements**.

Even **composite systems** (snowfields, locusts swarms, human masses) can be more or less easily distinguished from their environment.

Environment (Types of)

R.O. MASON distinguishes four different types of environments (for **organizations**, but it seems applicable to any type of systems):

"1. Placid, **randomized**: In the simplest type, **goals** and noxians are relatively unchanging in themselves and randomly distributed. A critical property from the **organization's** viewpoint is that there is no difference between tactics and **strategy**, and **organizations** can exist adaptively as single, and indeed quite small, units. The implication of this environment for a system is that it makes it stable and relatively unchanging..."

"2. Placid, **clustered**: (this) type is also static, but **goals** and noxians are not randomly distributed; they hang together in certain ways. Now the need arises for **strategy** as distinct from tactics. Under these conditions **organizations** grow in **size**, becoming **hierarchical** and tending towards centralized **control** and **coordination**..."

"3. Disturbed, reactive environment: (this) third type is **dynamic** rather than **static**. It consist of a **clustered** environment in which there is more than one system of the same kind, i.e. the **objects** (sic) of one **organization** are the same as, or relevant to, others like it. Such competitors seek to improve their own **chances** by hindering each other, each knowing the others are playing the same **game**... **Control** becomes more decentralized to allow (**operations**) to be conducted. On the other hand, **stability** may require a certain coming to terms between competitors.

"4. Turbulent **fields**: The fourth type is **dynamic** in a second respect, the **dynamic** properties arising not simply from the **interaction** of identifiable **component** systems but from the **field** itself... The **turbulence** results from the **complexity** and multiple character of the causal **interconnections**... At this fourth **level** the **concept** of **efficiency** is superseded by the **concepts** of survival and **effectiveness**" (1979, p.18-19).

1121

ENVIRONMENT (Active)^{1) - 2)}

That part of the environment with whom the system carries out frequent or decisive exchanges.

The whole **universe** is the environment of any system. However, from a practical viewpoint, the **effects** of most of the environment on the system (or conversely) are infinitesimal or extremely unfrequent.

The modelizer should however beware of which could be called the "still" or "silent" environment, which is related to very long term **transformation** factors. These are generally unknown or ignored, but may very well appear at any **time** in a quite unsuspected way and play havoc with the system (or offer it undreamed of opportunities). Typical cases are a volcanic eruption, or the millennial flood of a river or, in a positive sense, an unexpected scientific or technological discovery.

1122

ENVIRONMENT as a filter¹⁾

R. MARGALEF equates biological mutations with **noise** in the **information** that specify the **organization** of the **organism** through **messages**.

He quotes H. JACOBSON who writes: "Those **messages**, which pass through the **filter** (environment) with a **gain** equal to, or greater than unity cause **positive feedback** (self-sustaining continuation of the species). Those noisy **messages** which cannot pass through the **filter** (unfavorable mutations are rejected (bred out of the species) after a sufficient number of transmissions about the **loop**. Eventually the **message** takes on a character which is primarily due to the **filter**, in which the **gain** is maximized (natural **adaptation**). And the maximal **gain messages** may be vastly more complex than the original **message** (**evolution**) (1955, p.119-27).

The concept is clearly valid for any kind of environment.

1123

ENVIRONMENT (Benign)¹⁾

An environment whose activity does not force the system out of its **stability range**.

This notion has been proposed by R.N. ADAMS (1988, p.60). In a benign environment, the basic conditions for the sustainability of the system's **processes** and global **homeostasis** are always present.

1124

ENVIRONMENT (Dynamic)¹⁾

That part of the environment whose **transformations** are at the same **time scale** as the system.

H. OZBEKHAN (quoted by J.L. LEMOIGNE) writes: "... the word environment has been understood as too static. Reference is more and more made to *situations* in order to describe environments which change constantly; this expression connotes a dynamic environment, made of a conjunction of **events**" (1977, p.65).

A dynamic environment *requires adaptability* from the system. A more or less **homeostatic** environment admits more or less **homeostatic** systems. On the contrary, for an **emergent dissipative system**, as stated by R.N. ADAMS: "... a favorable environment is one that provides the necessary **resources** to enable it to continue its **dissipative process**" (1988, p.124).

It is a very serious mistake not taking into account some active **part** of a system's environment and it generally leads to uncorrect **forecasting**. This is a result of the frequently static appearance of the environment and the lack of **perception** by the modelizer of the different lengths of natural or induced **cycles**.

1125

ENVIRONMENT (Fragmented)

→ Fragmentation

1126

ENVIRONMENT FUNCTION^{2/5)}

W. POWERS states: "The **environment function** ... is what links the **action** of the **control system** back to its **perception**, through a **feedback connection**". (1995, p.7)

This means that the control system must have a permanently adjusted **knowledge** of the varying **environmental** conditions.

This is obtained through specific captors or **sensors**. For every complex system, as living **organisms**, and specially human beings, the environmental function becomes very intricate, as the desired **controls** must be multiple and simultaneous.

It becomes the entire field of neurological perception and cerebral interpretation and **integration** of very differentiated sets of **data**.

1127

ENVIRONMENT: Heterogeneity in space and/or time¹⁾

In theory, an environment can be **heterogeneous**, i.e. patchy in **space**, but constant in **time**... or, conversely, be uniform in **space**, in some specific place, but **heterogeneous** in **time**... and, of course, more or less **heterogeneous** both in **space** and **time**. (R. LEVINS, 1961, p.34).

S.R. REICE writes: "The environmental **patchiness** is based on physical and chemical **gradients** that are ubiquitous" (1994, p.427).

This ecological view can be applied as well to economic environments, for example.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Stability in **time** may allow for the **survival** of even quite narrowly adapted systems, while on the contrary the opposite demands for a great adaptive **variety**.

Growing exigences of a **population** on an environment may transform it in **time**, i.e. render it **heterogeneous**. In such cases, the **population** is creating hazards for itself.

1128

ENVIRONMENT (Perceived)^{1) - 3)}

E.von GLASERSFELD writes: "Jacob von UEXKÜLL, in his "Streifzügen durch die Umwelten von Tieren und Menschen" clearly showed that the **representation** that an **organism** builds from its environment can only be made from "raw materials", that the **organism** deals with in a way to define its own "experienced" environment" (1991, p.21).

Or, "... the observed **organism's** environment is still part of the **observer's** own experiential field" (1976, p.118). Thus, the *same* environment seen by a rabbit, or a fox, or a child or a human adult is perceived quite differently by any of them.

The same author adds: "Our sense **organs** perceive **distinctions**, and not 'objects'" (Ibid).

In any case, as stated by V. CSANYI: "The most important biological **function** of the animal **brain** and **memory** is the construction of a *dynamic model of the environment*, the continuous maintenance and **operation** of the **model**, and the use of the **data** obtained by **operation** for prediction in the interest of the **survival** and the reproduction of the animal" (1993, p.265).

According to D. MACKAY, this is the effective **meaning** of **mind** and **consciousness** (1951, p.118).

A quite serious problem is the existence of an *un-perceived* environment. This comes out very clearly in the following J.J. GIBSON's debatable statement: "The environment of animals and men is what they perceive" (1986, p.15). This is acceptable only from the viewpoint of psychology of **perception**, but should never be admitted as meaning: "What we do not perceive does not exist".

H.von FOERSTER's statement: "The **environment** contains no **information**. The environment is as it is" (1981, p. 271) makes this yet clearer. In fact, and obviously "what we do not perceive does not exist FOR US"

The **structural coupling** between the system and the environment creates or modifies the **meaning** within the system which thus becomes (better) informed, but always in function of its own **reference frame** (**operational closure**)

Finally, it is the system which somehow makes itself "informed"

1129

ENVIRONMENT (Stochastic)^{1) - 3)}

Environment whose characteristics are partially **random** for the system that depends on it.

Such a situation considerably diminishes the predictive ability of the system, which must then possess a quite higher **variety** (ASHBY), better countervailing **reserves** (VENDRYES), or a better **organizational closure** (MATURANA and VARELA).

According to M.P. SCHUTZENBERGER, in such a case: "...the optimal **strategy** is just the simple tactic of attempting to do one's best on a purely local basis" (1969, p.211). One could add... "on the basis of a short term evaluation".

The **random** character of the environment can be reduced in some cases by a better **input of information**, which can be obtained by the use of better **sensors**, captors or **depictors**. More adequate **models** are also very helpful.

A totally or excessively **random** environment would not allow for the **survival** of any system.

1130

ENVIRONMENT-SYSTEM CORRELATION¹⁾

R.L. ACKOFF defines the environment of a system as "a **set of elements** and their relevant properties which are not part of the system, but a **change** in any of which can produce a **change in the state** of the system" (1972).

He adds: "Thus a system's environment consists of all **variables** which can affect its **state**" (Ibid).

Some **variables changes** are frequent and obvious. Other are infrequent, nearly imperceptible, are or *seem* irrelevant. Such **changes**, the most difficult to detect, are also the more potentially unsettling.

The vocabulary used in the former paragraphs: "relevant, obvious, imperceptible, detect", indicates that the **distinction** between the system and its environment, as witnessed by the **observer**, is more or less arbitrary, even if some **criteria** "are better (in relation to **goals** and **means**) than others" R. VALLÉE, 1995, p.17).

The environment-system correlation also offers an interesting evolutive aspect. Starting from the simplest molecules on, the more and more **complex systems** that appeared through **time** showed a tendency to absorb a growing number of environmental **elements** and to create their own internal **organization** (endowed with **organizational closure**). As such, an "**environment**" must be protected from excessive **disturbances** from outside. The environment-system **correlation** may be variable in **time**, for example through an **evolution** from passive **adjustor** systems to more active **regulator** ones. This can be obtained by a number of features and the corresponding devices:

1. The most primitive systems adapted by simple **responses** to outside **stimuli**, as for example running away from unsuitable conditions.

2. More evolved systems created **sets** of alternate **behavior**, corresponding to a **variety** of possible environmental **disturbances**. This supposed the appearance of a kind of **storage** of previous experienced environmental **sequences**, and of a **selection** device for choosing the adequate **response** to specific **situations**. This implies at least a limited **knowledge** of the **environment's** properties. Inherited genetic **codes** store such **knowledge**, and **learning** is a way to acquire it, while **memory** is a way to store it.

3. As the system's internal **image** of its **environment** becomes more complete (which is the case for man), it becomes evermore able to **control** and to **transform** it, and even re-create it... but also at the same time and in some sense, more dependent of it. This may be dangerous for any human system if its **understanding** of its relation with its **environment** is not adequate.

→ **Reference (frame of); Variable (environmental)**

1131

EPIDEMICS¹⁾⁴⁾⁵⁾

The massive, swift and generally accelerating **propagation** of some **effect** in a **population**.

The population can be vegetal, animal or human, and is in fact a more or less dense congregation of individuals in a determined area.

The effect is generally biological (some disease, for instance). In human populations it can also be psychological (a rumor, a fad, a mode or, unfortunately a fear, a panic, some fanatical creed).

The effect is generally fed by some available **resource**, as for example a population devoid of immunological defenses or unexperienced, gullible and devoid of psychological and rational resistance.

An epidemic generally follows an evolving **curve**. It begins slowly and locally. Thereafter it starts to propagate in **space** and its **tempo** accelerates under the effects of contagion, which acts as a **positive feedback**, favored by conditions of close **proximity**.

After a period of seemingly exponential expansion, it starts to slow-down, as result of the growing elimination of the low resistance individuals. This acts as a **negative feedback** in sparser populations.

After a time, the epidemic subsides. It may disappear entirely, because it killed all (or at least nearly all) of the susceptible individuals. The pathological effect may also maintain itself marginally, as endemic in some section of a population.

Epidemic is obviously a very general **systemic process**.

→ **Explosive-implosive process; Growth; Meme; Pandemic; Percolation; Small world**

1132

EPIGENESIS¹⁾ - 2)

The progressive **structural** elaboration of a system produced by the interplay of some **rules** within a specified **environment**.

Epigenesis as a **concept** originated in biology, more than two centuries ago (K. WOLFF, 1767, as quoted by J. CASTI, 1990, p.137). "It means that *all* of the adult **organism** is present in codified, rather than actual, form in *all* fertilized eggs in *all* species... The difficulty with WOLFF's theory is that it says nothing about *how* the **set** of instructions in the fertilized egg becomes translated into the final adult **form**" (p.138).

This problem has been finally tackled in the second half of this century and seems nearing its solution.

In 1967, St. KAUFFMAN, as quoted by W. McCULLOCH, proposed that: "... a **random net** of **neurons**, each listening to two **neurons**, and each speaking to two, and the sixteen **Boolean functions** tossed into the **neurons** at **random**, would form a good **model** of epigenesis. These **nets** must exhibit recurrent **behavior** sequences called **state cycles**. KAUFFMAN found that with two **inputs** per **element**, **nets** typically do have very short stable **state cycles**, and very few **state cycles**" (1974, p.14).

This implies that such systems tend toward **organizational closure**. There is some analogy with the progressive **stabilization** of ASHBY's **homeostat**.

Moreover, epigenesis is a no-return trip. (see hereafter).

→ **Autogenesis; autopoiesis; Equipotentiality; Structuration (Dissipative); Zero-system**

1133

EPIGENETIC LANDSCAPE¹⁾ - 2)

The set of historically acquired conditions that guides further **evolution** within some defined **limits**.

C. WADDINGTON, who was a biologist, proposed this **concept** and commented: "The **process** starts there in a single valley, but this later branches into two or more, and these branches split up again and again, until they have formed a number of separate valleys corresponding to the separate **parts** of the adult animal" (1977, p.141).

"Valley" should be understood in the topological meaning of "**basin**".

St. BEER, in turn, writes: "The genetic **process**, with its **random** mutations, is nonetheless conditioned by the prior history of the species" (1968, p.367). This is also true for the **development** of any individual **living system** and for any human **organization** or **artefact**.

What is not yet quite clear is why and how this potential capacity for branching into a fully organized system becomes actualized.

However, the following quotation about St. KAUFFMAN's understanding of epigenesis (by W. McCULLOCH, 1974, p.14) throws some light upon this point: "Interpreting each **state cycle** - a stable mode of **behavior** of the **model** genetic **net** - as a distinct **cell type**, he modelled the epigenetic landscape as **flow** among the "**cell types**" induced by **random** minimal **perturbations** to a running system. He found that such systems "flow" down an epigenetic landscape to a **subset** of **cell types**, and remain trapped among them... **Simulation** proved him right in **model** genetic **nets** of anything up to 8.000 **components**, beyond which computer memory balks" (1967).

MARUYAMA's model of **deviation-amplification processes** clearly shows how the **process** closes on itself and how the system "becomes trapped".

Anyhow any **evolution** can be understood as a "funnel" open in the direction of the future: anything remains possible, but then only within the conditioning **limits** of the already stabilized **forms of organization**.

There is seemingly an **organizational closure** at the **mega-evolution level**.

1134

EPISTASIS²⁾

An adaptive **effect** obtained only when all the **components** in the **adaptive process** are present and properly working together (See HOLLAND, 1992, p.10 and 34)

The epistasis **effects** are characteristically **nonlinear**.

1135

EPISTEMOLOGY (Evolutionary)^{2/5)}

The evolutionary study of **cognition**. A. RANDRUP, commenting on the new journal "Evolution and Cognition" of the K. LORENZ Institute for Evolution and Cognition Research, Austria, writes: "The studies of evolutionary **cognitive** apparatus is a product of biological evolution" (1997, p. 69)

This opens a wide field of research in **cognitive science**.

1136

EPISTEMOLOGY (Systemic)³⁾

"The **set** of viewpoints and instruments used by ... researchers... to discover and organize **coherence**, derive consequences and connect

ideas in order to construct their inner **mappings** and to orient themselves" (W. KARGL, 1991, p.580).

KARGL's plural is symptomatic: Systemic epistemology is related to the **activity** of **observers**, and observed **observers**, comparing their views.

Similarly, in R. VALLÉE "**Epistemo-praxeology**" "...**subjectivity** is underlined, but **objectivity** is in no way excluded, where **interactions** between subjects imply **observations**, **decisions** and result in **actions** that modify the subjects themselves in a more or less significant way, according to issues. These **objectivity** perturbing **interactions**... can be reduced by efforts which become greater as the reduction is more radical. The best is to accept them, without ignoring their presence. This subjectivist epistemology cannot be separated (without an arbitrary decision) from a **praxeology** (1987, p.45-6).

KARGL and VALLÉE viewpoints are mainly **constructivist** ones. Besides coincidence, **coherence** and **connectivity** seeking are indeed quite systemic ways.

L.von BERTALANFFY considered that "The investigation of organized **wholes** of many **variables** requires new **categories** of **interaction**, **transaction**, **organization**, **teleology**, etc., with many problems arising for epistemology, mathematical **models**, and techniques. Furthermore, **perception** is not a reflection of "real things" (whatever their metaphysical status), and **knowledge** is not a simple approximation to "truth" or "**reality**". It is an **interaction** between knower and known, and is dependent on a multiplicity of factors of biological, psychological, cultural, linguistic, etc., nature... Against **reductionism** and theories declaring that **reality** is "nothing but" (a heap of physical particles, genes, reflexes, drives, or whatever the case may be), we see science as one of the "perspectives" that man with his biological, cultural and linguistic endowment and bondage has created to deal with the **universe** in which he is "thrown", or rather to which he is adapted owing to **evolution** and **history**" (1975, p.166-7).

The most significant parts of this text are probably the quotes used with "truth" and "reality", words whose absolute **meaning** is reflected upon within systemics.

See: "**Ontological skepticism or agnosticism**".

BERTALANFFY also stressed the concern of "systems philosophy" with **values**: "I do not see that these humanistic aspects can be evaded if **general system theory** is not to be limited to a restructured and fractional vision.

"Thus there is indeed a great and perhaps puzzling multiplicity of **approaches** and "trends" in **general system theory**. This is

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

understandably uncomfortable to those who want a neat formalism, e.g. the textbook writer and the dogmatist" (p.167).

Accordingly T. SANDOZ writes: "Systemic epistemology supposes not only a new way of seeing problems or **modelling** systems properties, but another "culture". In fact, real-life **problems, actions and methodological** issues have to be developed together (**co-evolve**). In other terms, **systems science**, with the help of **constructivist** philosophy, should propose a new world of questions (what G. BATESON called a 3rd order **change**) and not only more pertinent **models** and formalizations" (1993, p.1543).

Systemic epistemology is thus essentially based on multiple reciprocal **relationships**. (see "**Definition**").

A typical case is the way **chaos theory** has modified the relation between the seemingly opposed concepts of **determinism**, and **randomness**. **Randomness** may mask some hidden **determinism**, and the opposite. Complementary **models** are thus admissible and frequently useful.

Systemic epistemology should also be evolutive. As, stated by D. CAMPBELL, **organisms** seek to increase their **fit** to their **environment**. (Quoted by E.von GLASERSFELD, in his paper "Konstruktion der Wirklichkeit und des Begriffs der Objektivität", 1991, p.27, in itself a **constructivist** manifest).

From another viewpoint, G. KLIR observes that systemics imply an "epistemological **hierarchy**, whose key feature "is that every system defined on some **level** in the **hierarchy** entails **knowledge** associated with all corresponding systems on lower **levels** and, at the same time, contains some **knowledge** that is not available in any of these lower systems.

"The number of **levels** in the epistemological **hierarchy** is potentially infinite. In praxis, however, only a small number of **levels** is considered" (1993, p.33).

An interesting example is J.G. MILLER's **taxonomy of living systems**, selecting 8 **levels of complexity**.

1137

EPISTEMO-PRAXEOLOGICAL CLOSURE²⁾ - 3)

Situation resulting from the "**feedback** to the **input** x of the system (**evolution** of the system and its **environment**) obtained through the **effectors** controlled by the **decisions**" (R. VALLÉE, 1990, p.40).

R. VALLÉE explains this concept as follows: "The **cybernetic system** S acquires a **knowledge** of itself and of its **environment** F by way of its **observation organs**... These **perceptions** generate **decisions** which command S 's **effectors**. These **effectors**, by their **simultaneous action upon** S itself and upon F modify the **evolution** that S and F would have undergone

without their intervention. An *indirect consequence of that perception which S obtains from itself and of its environment is thus to modify this perception*. In this sense, the system knows itself and constructs itself, and knows and constructs its **environment**" (1991, p.145-146).

VALLÉE calls this **process**: *Epistemo-praxeological cognition*. He adds that "This **co-evolution** is akin to what Heinz von FOERSTER calls "**Eigen Behavior**" (von FOERSTER, 1981, p.274), but which in this case refers only to S " (Ibid)

VALLÉE's concept, also elaborated by him in various papers as a mathematical formalism, is thus at variance with MATURANA and VARELA's **organizational closure**, as it does not readily dissociate the system from its **environment**. VALLÉE explains how his views "modify the notion of **subjectivity**" in the following terms: "In the **co-evolution**, or the **symbiosis** of two observing and acting **subjects** S_1 and S_2 , the **image** that they gather from each other... is on various **levels**: the **observation** one, the **decision** one, or more synthetically, the **action level**. But, if **subjectivity** is underlined, **objectivity** is in no way excluded. The epistemological, pragmatical and praxeological images that S_1 obtains from itself and from S_2 are determined by the **state** of S_1 and S_2 , that is only defined at a *meta-level* out of reach for S_1 and S_2 ." (1995, p.102). These views come closer to LOTKA's "**planetary engine**", LOVELOCK's "**Gaia**" and GRASSÉ's **stigmergy**.

For a complete development of the epistemo-praxeological concept, see R. VALLÉE's "Cognition et système" (1995).

A quite similar concept has been enunciated by R. MARGALEF: "When we interfere with the functioning of nature, we are converted into **parts** of the larger system, such as the experimenter is included in the experiment" (1980, p.39).

Epistemology in a systemic sense is thus in no way independent of the very progress of rational **knowledge**, which eliminates former areas of ignorance (non-rational explanations or no explanation at all), but creates new ones, as the intrusion of formerly unrecognized or non-existent **effects**.

1138

EQUIFINALITY¹⁾ - 2)

1. Property of a system able to reach a final **state** starting from different **initial conditions** and by different ways (Adapted from J.G. MILLER, 1978, p.41).

The equifinality concept was introduced by L.von BERTALANFFY (1940, p.521).

Equifinality is possibly more a seeking **behavior** than a property.

MILLER gives anyhow, on basis of the equifinality property, a new interpretation of DRIESCH's experiment of cutting an embryo of a sea urchin in two halves, each of which remains still able to produce a normal sea urchin.

Thus a **cybernetic-systemic understanding** of a general **process** replaces a vitalistic interpretation.

MILLER writes: "The obvious **purposive activities** of most **living systems**, which may have seemed to many to require a vitalistic or **teleological** interpretation, can be explained as **open-system** characteristics by means of this principle. Some **open physical systems** also have this characteristic" (p.41).

Equifinality operates by regulating **feedbacks** and becomes more efficient when the system is endowed with more **variety**.

However as noted by Stafford BEER, "death is equifinal" as a result of the **ageing process** in any **autopoietic** system, definitively unable to escape from **organizational closure** (as anyone of us).

Another shade of **meaning** is equifinality by **irreversible thermodynamic transformation** towards a **state** of maximum **entropy**: "Given the final **state** with maximal **entropy**, it is impossible to know which initial **state** led to this result" (F. HEYLIGHEN, 1989, p.366).

2. "The ability of living **organisms** to reach an initially predetermined final **state** in spite of **perturbations** in the **initial conditions** (proceeding from different initial **states** and by different routes)" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.49).

BLAUBERG et al add: "In **closed systems** their final **states** (e.g. distribution of matter concentrations) are entirely determined by the **initial states**, which is reflected in the corresponding "mechanistic" formalism" (Ibid).

Let us remember the ambiguity of the "**closed system**" model.

R. ROSEN describes equifinality as "... the stubborn tendency of a developing system to reach the same final **state** despite such experimental interventions as amputations, randomization or hybridization" (1979, p.176).

The predetermined character of the final **state** is a necessary consequence of the 2d. **Principle of thermodynamics** which prescribes an irreversible increase of **general entropy** with **time**. However (and paradoxically) **complex systems** become highly organized by creating **heterogeneous structures** through **dissipation** of growing quantities of **energy** obtained from their **environment**, but at the price of rejecting more **entropy** in this same **environment**.

This type of situations has been clarified by PRIGOGINE, within the **frame** of his **thermodynamics of irreversible systems**

1139

EQUIFINALITY PRINCIPLE¹⁾

"In **open systems**... the same final **state** may be reached from different initial conditions and in different ways" (L.von BERTALANFFY, 1956, p.4).

BERTALANFFY observes that this is not the case in **closed systems** and gives as an example the *perfect previsibility* of the movement of the planets and of their position at some t_1 moment knowing their position at t_0 . (Ibid).

Let us remember that, nowadays, this **previsibility** is not anymore considered perfect (see: **Chaos**), which does not anymore allows for the unrestricted generalization of the equifinality principle to the physical systems.

The equifinality principle, as a conceptual **model**, replaces in biology the vitalist concept proposed by the German biologist H. DRIESCH based on his experiences on the development of sea urchins embryos: "The same final result, a normal individual of the sea urchin, can develop from a complete ovum, from each half of a divided ovum, or from the fusion product of two whole ova. The same applies to embryos of many other species, including man, where identical twins are the product of the splitting of one ovum" (Ibid).

BERTALANFFY adds: "... equifinality is not a mathematical characteristic but a physical characteristic of (certain) **open systems**. It does not depend on the **structure** of the system equations but on the **meaning** of the **parameters** so that formally identical equations may apply to non-equifinal **closed systems** as well as to equifinal **open systems**. However, the equifinal case where the final **state** depends only on the **reaction** and transport **parameters**, and not on the **initial conditions**, is found only in **open systems**" (Ibid).

In spite of its evident importance, the equifinality principle presents serious interpretative difficulties. For example, the *same* system necessarily starts from one and only one initial set of conditions and while it *could* follow different **paths** for its **transformations**, it will really take one, and only one.

Let us also remember the semantic **ambiguities** concealed under the concepts of "**open**", "**closed**" and "**isolated**" system.

1140

EQUI-INITIALITY¹⁾

"The (conventional) scientific notion (applicable to "**closed systems**") that "identical" **initial conditions** will necessarily result in "identical" final **states**" (D. Mc NEIL, 1995, pers. comm.).

This neologism is basically another way to enounce the basic tenet of classical **determinism**. It is at the same time an axiom and a belief, neither entirely verifiable on **concrete sys-**

tems, since none is ever identical to any another one. The concept has been introduced by Mc NEIL as a kind of counterpoint to be compared to the **equifinality** one.

1141

EQUILIBRATION²⁾

Progressive **stabilization** of the internal **functions** of a system normally active in its specific **environment**.

This term has been introduced by J.L. LEMOIGNE who describes as follows the different types of equilibration in his **model** of "**Système général**". (i.e.: General **model** of the system):

- by **regulation**, if the system maintains a stable relation with its **environment**. This mode leads to **homeostasis**
- by programed **adaptation**, if the system's relation with its **environment** is changing. This **mode** corresponds to **homeorhesis** in a growing system.
- by recoding, a **mode** called **homeogenesis** by LEMOIGNE. Such a mode of equilibration implies probably a master **program** of **programs**.
- by structural **adaptation**, when the system itself is changing its **goals**. LEMOIGNE calls this transformation (with hyphen) and, while he does not explicit the idea, it seems to be the mode of equilibration of human **organizations**.

LEMOIGNE presents a last type of equilibration, by structural **evolution** – which he equates with **morphogenesis**, but which seems to be no equilibration at all, if it is understood as the complete recasting of the system by **dissipative structuration** due to giant **fluctuations far away from equilibrium**.

1142

EQUILIBRATION THEORY²⁾³⁾

This theory, elaborated by J. PIAGET (1975) is at the same time a biological, a psychological and a conceptual one. E.von GLASERSFELD writes: "For PIAGET, **knowledge** is adaptive insofar as it enables us to **control experience** and to maintain our **equilibrium**. I hasten to add that "equilibrium" is a **multilevel concept** that covers **survival** on the physical/biological level as well as **coherence** and non-contradictions in the conceptual sphere.

"This is one of the points where, I think, Humberto MATURANA and PIAGET are in agreement. MATURANA speaks of "effective action" – and it is easy to translate "effective **action**" into PIAGET's terms as any action that maintains or restores the actor's equilibrium" (1992, p. 24)

von Glasersfeld makes also a connection with B. POWERS' theory of **control** of **perception** (1973). Any move to counteract what Powers calls an "**error signal**" is indeed always a move towards equilibrium (Ibid)

1143

EQUILIBRIUM¹⁾

"A **state** of a system which keeps certain properties **invariant**" (G. PASK, 1961, p.114).

This is merely one of the many more or less complementary definitions that can be encountered in the literature. It is sufficiently general to include different kinds of equilibrium (see hereafter).

For PASK: "The term includes not only **static equilibria** – an object at rest – but also **dynamic equilibria** and statistical equilibria" (Ibid)... which of course are quite different **situations**.

W.R. ASHBY gave examples of three basic types of equilibrium:

"Stable equilibrium" typified by "a cube resting with one face on a horizontal surface".

"Neutral equilibrium", the case of "a sphere resting on a horizontal surface".

"Unstable equilibrium", the case of "a cone balanced on its point" (1960, p.44).

More recently K.De GREENE distinguishes four kinds of equilibria: equilibrium per se, restorable disequilibrium, **multiple equilibrium** and **nonequilibrium/far-from-equilibrium**.

He states: "The major emphasis of **system dynamics**, at least formally, is on the first two conditions. The third condition is studied by **catastrophe theory**. The fourth condition is emphasized by **dissipative-structure** theory and by **synergetics**" (1994, p.7).

Generally, equilibrium is a **state** in which a system tends to remain if no **disturbance** deflects it from the same.

Homeostatic systems (i.e. systems endowed with **dynamic equilibrium**), when disturbed, tend to return, to "bounce back" from their **stability thresholds**, through **negative feedback** and thus to remain within a well defined **stability channel**.

A system in equilibrium is "short-sighted", i.e. has no **sensitivity** to long term **trends**. Curiously enough, our own appreciation of equilibrium in systems whose duration is very large in relation to our own life-time also tends to be "short-sighted": it is very difficult for us to develop a **sensitivity** to long or very long **rhythms of change**.

Equilibrium can also be an instantaneous and transient **state** of a system submitted to a **periodic process**.

A. BOGDANOV called such variations "a dynamic equilibrium of **changes**" wherein "Preservation is always only a result of immediately equilibrating each of the appearing **changes** by another opposing **change**" (1980, p.78).

This is in fact an extension of **LE CHATELIER Principle**.

The **transition** from an unstable to a stable and definitive equilibrium reflects the **action** of some **asymptotic attractor**, which corresponds to a **gradient** characterizing the successive values of the **variable**.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

W.R. ASHBY expresses this as follows: "Given a **field**, a **state** of equilibrium is one from which the representative point does not move" (1960, p.46).

Arguably, ASHBY could have added "...any-more", since in the very next paragraph he states: "Notice that this definition, while saying what happens *at* the equilibrium **state**, does not restrict how the **lines of behavior** may run around it. They may converge into it, or diverge from it, or behave in other ways" (ibid).

Static equilibrium – and subsequent **destruction** – is anyway the final **state** of any **living system**.

1144

EQUILIBRIUM (Asymptotic)²⁾

This is the type of equilibrium toward which tends a system whose successive **states** are fully determined by the initial **energy** available to it. In such a case, the system is never able to **autonomously** leave its final equilibrium, once reached. The system responds to a punctual **asymptotic attractor**.

In a more general sense, **homeostatic** systems with **inputs of energy** also tend to asymptotic equilibrium. In this case it seems that the cause of **decay** is the originally limited capacity to assimilate **information**, resulting from their **organizational closure**. In St. BEER words: "Death is **equifinal**"!

→ "Eigen time".

1145

EQUILIBRIUM (Dynamic)²⁾

The condition of a system whose **processes** may **fluctuate** within more or less ample **limits**.

This is practically a synonym for **homeostatic equilibrium**.

1146

EQUILIBRIUM (Ergodic)²⁾

The global **state** of a system which is able to transit randomly from one specific **state** to another, within a defined **set** of possible **states**.

Ergodic equilibrium is **invariant**, as explained by G. PASK (1961, p.122), since the global **values** of the probabilities **distribution** do not change and are independent of the initial **state**.

1147

EQUILIBRIUM (Far-from)²⁾

The condition of a system undergoing ever widening **fluctuations**.

Such condition generally heralds the beginning of **dissipative structuration**, if and when an important surplus of **energy** is available. In G. NICOLIS and I. PRIGOGINE words: "... the distance from equilibrium and the **nonlinearity** may both be sources of **order** capable of driv-

ing the system to an ordered **configuration**. A highly non-trivial **connection** between **order**, **stability**, and **dissipation** appears. To indicate clearly this relation we call the ordered **configurations** that emerge beyond **instability** of the thermodynamic branch the **dissipative structures**" (1977, p.60)

Once crossed the **instability threshold**, the system's **behavior** undergoes a drastic **change**, thus described by I. PRIGOGINE: "... the **thermodynamic behavior** could be... in fact, even directly opposed that predicted by the theorem of **minimum entropy production**" (1980, p.88).

According to K.DE GREENE: "... nonequilibrium is the source of **order**; it brings **order** out of **chaos**... Far-from-equilibrium situations induce a new **coherence** among system **elements** via new **patterns of communication**" (1994, p.9).

The far-from-equilibrium condition should be clearly distinguished from the near-equilibrium one, in which the system only fluctuates moderately within narrow **limits** and remains **homeostatic**.

1148

EQUILIBRIUM (Global)^{1) - 2)}

W.R. ASHBY states: "That a whole **dynamic system** should be in equilibrium at a particular **state** it is necessary and sufficient that each **part** should be in equilibrium at that **state**, in the conditions given to it by the other **parts**" (1960, p. 79).

Of course, this is an "ideal" **state**, never practically reached by a **dynamical system**, as ASHBY himself recognizes: "Clearly at any **state** of the **whole**, if a single **part** is not at equilibrium (even though the remainder are) this **part** will change, will provide new conditions for the other **parts**, will thus start them moving again, and will thus prevent that **state** from being one of equilibrium for the **whole**. As equilibrium of the **whole** requires that all the **parts** be in equilibrium, we can say (metaphorically) that every **part** has a power of veto over the **states** of equilibrium of the **whole**" (ibid).

Practically, the **oscillations** will be permanent.

1149

EQUILIBRIUM (Homeostatic)^{1) - 2)}

A dynamic equilibrium, characterized by **oscillations** within more or less narrowly defined maxima and minima **limits**.

K. BOULDING described it as follows: "Equilibrium is simply a **dynamic process** in which the dynamic **path** of the system leads to a **reproduction** in successive **states** of some initial equilibrium **state**. "Staying the same" is simply a special case of "changing" (1972, p.68).

Homeostatic equilibrium does not allow for basic structural or functional **changes** in the system, i.e. is never evolutive, even if it is adaptive. It remains in basic accordance with the laws of classical **thermodynamics**.

L.von BERTALANFFY made the following comment: "If life, after **disturbance** from the outside, had simply returned to the so-called homeostatic equilibrium, it would never have progressed beyond the amoeba which, after all, is the best adapted creature in the world – it has survived billions of years from the primeval ocean to the present day. MICHELANGELO, implementing the precepts of psychology, should have followed his father's request and gone in the wool's trade, thus sparing himself lifelong anguish although leaving the Sistine Chapel undecorated" (1971, p.192).

1150

EQUILIBRIUM (Levels of)¹⁾

As a result of complex intertwining of different functional **cycles** in the variations of a **complex system's behavior**, different levels of equilibrium may become dominant at different moments.

K.DE GREENE states: "At any period the system hovers around an equilibrium level. Over **time**, **deviations** from equilibrium may expand or contract" (1988, p.283).

This author, who reconsiders the whole subject of **cycles**, explains that, in economic **cycles**, "KONDRATIEV identified at least three orders of equilibrium:

"1. first order equilibrium of short duration...

"2. second order equilibrium of intermediate duration...

"3. third-order equilibrium of longest (but nevertheless limited) duration" (ibid).

Short duration corresponds to more or less small and local **random** movements of quite limited **amplitude**, channelled within medium and long term trends

2d order movements are related to more permanent **trends**, while 3rd order ones are related to the most basic and general alternative conditions that the system may possibly have to adapt to.

There can be more than three levels of equilibrium.

On the other hand "short, intermediate and long duration" are defined in relation to the nature of the system. They have different **meanings** for the **growth** of some annual plant and for sequoias, for flies and for elephants.

Levels of equilibrium, described by KONDRATIEV in economic **cycles**, command undoubtedly the **dynamics** of numerous other types of systems, specially those in **homeostatic** conditions. **Transitions** from one level to another can be sudden, and thus **catastrophe** and **chaos** theories could be useful to formalize **models**.

1151

EQUILIBRIUM (Metastable)^{1) - 2)}

An equilibrium that remains stable until some **trigger element** is introduced in the system, but undergoes a sudden **change** when such **element** appears.

Such equilibria are characterized by their potential for **growth**.

A. LOTKA states: "This is a common characteristic of the **growth** of **living systems**; **growth** is initiated by a nucleus of the same species of **matter** that is added... Conversely, in the entire absence of any nucleus of a particular species of living **matter**, **growth** of that species cannot take place, even though all other conditions for such **growth** may be satisfied, even though the system may, as it were, be supersaturated with regard to that species of **matter**" (1956, p.151).

This **phenomenon** is also well known in inorganic systems (supersaturated solutions).

Sudden epidemics in **populations** that overshooted their **environmental optimum** seem to respond to the same **trigger effects**: A case may have been the so-called "Black-Death" pandemic in Europe from 1347 on.

1152

EQUILIBRIUM (Multiple)^{1) - 2)}

"An area of **catastrophe theory** in which system **behavior** can flip unexpectedly from one **attracting** equilibrium to another" (K.DE GREENE, 1988, p.286).

DE GREENE emphasizes this type of equilibrium in relation to his study of the **interconnections** of **cycles**. He states: "In **catastrophe theory** the **attractors** are static **equilibrium points**. As a **control parameter(s)** "drags along" a **behavior variable**, the system may cross a **discontinuity** or **catastrophic** point, line, or surface and jump to another equilibrium **manifold**. This **activity** illustrates multiple-equilibrium **behavior**" (1994, p.8).

Unexpected flips occur when the superposition of various **cycles** of different lengths converge unto a same point and moment, which thus comes to be an **unstability threshold**.

The **switching** from one to another equilibrium corresponds to the **switching** from one **attractor**, corresponding to one **phase**, to another one.

Multiple equilibria, far from being merely an economic **phenomenon**, constitute a general **model of behavior** of many classes of systems.

1153

EQUILIBRIUM of flows^{1) - 2)}

The result of an adequate compensation between incoming and outgoing flows in a system.

J.de ROSNAY comments: "When equilibrium is reached, a certain **level** maintains itself through **time** (... concentration of certain molecules in plasma, or state of a bank account). This particular **state** is called **steady state** and is quite different from the **static state** figured by the water **level** in some tank without **communication** with the outside".

"An unlimited number of **steady states** are possible. This is what allows an **open system** to adapt and meet the enormous **variety** of the **environment's** modifications" (1975, p.118).

1154

EQUILIBRIUM of forces²⁾

The result of the nullification in one point of two or several equal but opposed forces.

Examples are a book lying on a table or a ball in a bowl. J.de ROSNAY comments: "An equilibrium of forces is static. It can be modified only by a **discontinuous change** in the ratio of forces. A succession of such **discontinuities** may lead to a **runaway event**" (1975, p.117-18).

1155

EQUILIBRIUM (Out of)^{1) - 2)}

A condition of a system heralding an imminent **change** in its relation with its **environment**.

If it is to maintain itself, the system must be able to expend **energy** as it seeks a new **equilibrium**.

1156

EQUILIBRIUM (Punctuated)^{1) - 5)}

The enhancement by successive stages, of **fitness** of some natural or artificial species.

The concept was originally proposed by H.J. Mac GILLAVRAY and developed by S.J. GOULD and N. ELDREDGE, as a **model of evolution** by jumps (L.M.VAN VALEN, 1995, p.270).

It has now been modeled by W.D. HILLIS, on a **population** of 65.536 artificial **elements** ("Ramps" - **elements** which climb a "**fitness** ramp"), each **element** being endowed with a number of "genetic" characteristics that can freely recombine in a **network**. "Testing the **fitness** of his "ramps" against a problem in their **environment**, he showed that "their gains in **fitness** proceeded by "punctuated equilibrium" - periods of **stability** were shattered by sudden leaps in **fitness** (as if)... **evolution** had found a new power that enabled the Ramps to deal with their **environment** more effectively... When HILLIS examined the "genomes" of the Ramps during the presumably **stable period** of **equilibrium**... he found that the gene pool was actually seething with activity, setting the stage for the next leap" (S. LEVY, 1992, p.206).

Just as in **evolution** of the living, this **process** of artificial **evolution** includes first diversification ("typogenesis"), next variation within narrow **limits** ("typostasis") and finally senescence by overspecialization ("typolysis") (On typolysis in animal species, see H. DECUGIS, 1941).

Punctuated equilibrium seems thus to be a general property of **networks** composed of numerous **variable elements** in **interaction**. This could be important in economics, **management** and social sciences.

Punctuated equilibrium implies that nature can be understood as a **non-equilibrium system**.

P. BAK writes: "The **concept** of punctuated equilibrium turns out to be at the heart of the **dynamics** of **complex systems**. Large intermittent bursts have no place in **equilibrium** systems, but are ubiquitous in **history**, biology and **economics**" (1996, p.29)

1157

EQUILIBRIUM STATES²⁾

Any equilibrium is necessarily related to the specific **dynamics** of the **environment** on which it depends for its permanence or modification. According to R.N. ADAMS: "Equilibrium **structures** do not have to do anything to maintain equilibrium; the **environment** does it all" (1988, p.124).

Three different states of equilibrium are generally recognized, as exemplified by ASHBY (see "Equilibrium"):

What differs in these three different types of equilibrium is the importance of the **environmental disturbance** needed to modify the existing **state**.

From the **topological viewpoint**, the same **states** could possibly be characterized as follows:

- **stable**: immobility after **convergence** on a uni-dimensional **attractor**;
- **neutral**: indefiniteness within the **limits** of a two dimensional **attractor**;
- **unstable**: included within a **chaotic attractor**, or running toward a one dimensional **attractor**.

1158

EQUILIBRIUM (Static)^{1) - 2)}

"A **time** independent **state** of a **closed system** in which all **macroscopic** quantities are invariable and all **microscopic processes** discontinued" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.47).

These authors write: "According to the **second law of thermodynamics**, each **closed system** finally reaches a **time**- independent state of equilibrium with maximum **entropy** and minimal free **energy**" (Ibid).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

It should be better **semantics** to call "**isolated system**" this purely abstract system to which the **2nd. law of thermodynamics** applies in a rigorous way.

This type of static equilibrium is quite different from the **dynamic equilibrium**, proper to **steady states** in active **dynamic systems**.

Static equilibrium is necessary a final **state** in any system, in accordance with the **2d Law of thermodynamics**. As stated by A. KATCHALSKY, such final **states** are "memoryless", i.e. do not conserve any trace of their former functionality or organization (1971, p.60-61). They normally imply the destruction of the system and the **dispersion** of its **components**.

1159

EQUILIBRIUM (Statistical) ²⁾

G. PASK writes: "By analogy with a **state-determined system** any **Markovian system** reaches statistical equilibrium. In equilibrium it is characterized by averages h_{ij} and, regarded as an **information source**, it has a measurable **variety**. For n states, the maximum **variety** is $\text{Log}_2 n$, the **variety** of the **reference frame**, without any statistical **constraints**" (1961, p.45).

This seems to correspond to the **limits of chaotic variation** in the dynamics of **complex systems**.

1160

EQUILIBRIUM SYSTEM

→ **System (Stable)**

1161

EQUIPOTENTIALITY ^{1) - 3)}

Condition of a system that, starting from its **initial state**, may reach different **states** of **dynamic stability**.

Just like with **equifinality**, this property can never be verified in **concrete systems**, which have each one and only one adaptive sequence.

J. SINGH goes however quite farther, and in a different interpretation, when he writes that this is "the property of a system in which remaining **subsystems** can fulfil the **functions** of **subsystems** that have been eliminated" (1972, p.157 – retranslated from Spanish!).

This would be possible only if some **subsystems** were **redundant**.

J. NEEDHAM reproduces DRIESCH's diagram of the characteristics of an harmonious equipotential system (1968, p. 52). Some embryonic element X as a **part** of the embryo forms simultaneously part of different potential **subsystems** and "its **prospective value** is different in each case." DRIESCH spoke of a "prospective potency", in order to signify the collection of

possible fates of such a part: the actual fate (the prospective significance) is chosen from among the possible fates (the prospective potency) (p. 53)

The original embryo has thus the general character of a **hologram**. this is confirmed by the fact that, after dividing the embryo a typically whole gastrula appears "differing from a normal one only by its smaller **size**" (p. 52).

This shows that the original embryo (and possibly any system in its initial stage- see CSANYI **zero-system**) has a specific potential for global differentiated **organization**.

NEEDHAM adds the following suggestive comment: "...one of the most fundamental **process** in **development** consists in the closing of doors, i.e., in determination, in the progressive restriction of the possible fates" (p. 55) and "Prospective potency (becomes) ruthlessly curtailed to prospective significance" (p. 56)

The foregoing shows the very general meaning of equipotentiality

→ **Constraint; Differentiation; Embryogenesis; Gradient; Holon; Positional value; Structure (Dissipative)**

1162

ERGODIC PROBLEM ^{1) - 2)}

The difficulty to determine the nature of the **behavior** of a system depending of various ill-defined **variables**.

According to J.S. GRIFFITH this problem appears: "... when the **long-term time** average of a property of a dynamical system is equal to the average of that property over the **phase space** of the system" (1965, p.92).

While this is a problem that originates in classical mechanics, it becomes more and more important for **complex systems**, particularly those not very strongly integrated, as **populations** for instance. It is now clear that it has a close relation to **networks behavior** and to **deterministic chaos**, in accordance with H. POINCARÉ first inklings, when he considered the **3-bodies problem**.

A basic character of **networks** is the presence of various simultaneous **initially unconnected conditions**, i.e. the basis for **chaotic behavior**.

All **determinisms** do not disappear in **chaos** and return of former **states** is always possible. However the "**long-term**" condition is of basic importance, because the reappearance of some specific **state** may need a very long **span** of **time** when the original conditions are numerous and out of **phase** on a considerable **scale**. Consequently, it may be very difficult to establish the ergodic character of a system's **behavior**.

1163

ERGODIC RELATION ²⁾

The character of the **behavior** of a system whose average transit between successive **states** in **time** statistically equates the probabilities of the different possible **states**.

L. BRILLOUIN enounced the ergodic hypothesis, already introduced by BOLTZMANN, in the following way: "The average of some relation, measured through a **period of time**, must be equal to the average of the same relation, taken on the surface of constant **energy**".

According to BRILLOUIN, the idea was "to follow some determined **trajectory** and to show that it progressively covers the surface of constant **energy**, in the way that a wire covers a coil or a thread the surface of a ball".

However there are some difficulties, thus stated by BRILLOUIN: "Some peculiar **trajectories** are **periodic**, close on themselves and do not cover the surface in a uniform way. Others reach **bifurcation** points where different probabilities must be introduced for different branches" (1959, p.189).

The mentally uncomfortable mix of **determinism** and **randomness** appears clearly in the former comment. The same problem is reflected in other comments by W.R. ASHBY about "**equilibrium** in a **MARKOV chain**" (1956, nr.9/6) where it can be seen that, within a **population**, the **distribution** of differently characterized sub-groups tends at any moment to be equal to the mean **behavior** through **time** of these groups. Such systems are neither perfectly **deterministic**, nor perfectly **random**: individual **randomness** is limited by the characteristics of the individuals, which define the **limits** of their **autonomous** and collective **randomness** in relation to the specific environmental conditions and to the global mix of the different types of **autonomous** individuals.

These intricate **situations** seems to be related to:

1. the general theory of **deterministic chaos**: the ergodic relation holds only so far as the system maintains itself within the **limits** of its **attractor**.
2. the **concept** of **organizational closure** as it might be applied to **populations** (in a very general sense).
3. and possibly the concept of **self-criticality** in **composite systems**.

These systems seem to possess a kind of collective, but **blurred memory** of their **initial conditions**, which become mixed up with **time**, but are never totally erased.

The **POINCARÉ section** seems to have been the first specific **ergodic relation**, characteristic of nearly **chaotic systems**, being also useful for the study of **periodic trajectories**.

1164

ERGODIC SET²⁾

The set of all the **states** which can be visited by an **ergodic system** (after G. PASK – 1961, p.123).

The ergodic set is called regular if "...each of the possible **transitions** can take place at any instant" (Ibid). This is not always the case, as some systems can be ergodic and, at the same time, subtly **cyclic** in the long term (Ibid).

1165

ERGODICITY^{1) – 2)}

Character of a system in which the average **values** of the **variables** evolve through **time** within the **set** of their statistically **invariant values** over all possible **configurations**.

Ergodicity reflects the existence of subagent global and invariant conditions which determine the **behavior** of the **variables** only in a statistical way, but within **limits**.

Y. SINAI considers as the basic problem of ergodic theory: "the analysis of the causes generating the appearance of statistical laws in **dynamic systems**" (1992, p.69).

The **behavior** of an **ergodic system** evolves within a **phases space** that becomes divided into subspaces. As expressed by S. DINER: "Ergodic theory is basically a theory of the **sets of trajectories**" (1992, p.348).

As shown by BIRKHOFF (1931), the most significant characteristic of ergodicity is that the average **behavior** of the system over a sufficient lapse of **time** tends to be equal to the average **configurations** in **space**. This average on **space** is independent of the **trajectory** considered and the average in **time** is independent of the initial point. The **behavior** is thus not truly **random** and could be called **para-random**.

In consequence, the **behavior** of **chaotic systems**, with a number of **initial conditions**, tends to be ergodic.

→ **Ergodic relation**, (according to ASHBY).

1166

ERROR²⁾

In a **regulator**, the difference between the real and the desired (**reference**) **input**.

The error is measured in an iterative way by the **comparator** and its **value** sent to the **controller** in order to produce the needed correction.

As the correcting **process** suffers necessarily a certain **time lag**, the error may never disappears totally and the regulating **process** turns iterative and continuously produces **oscillations** within some more or less wide **limits of amplitude**.

If the error changes from positive to negative – or the reverse – during the corrective **process**, the correction may well amplify the error instead of damping it.

1167

ERROR ACTIVATION²⁾

The **activation** of a corrective **response** by the **feedback unto the process** of the **difference** between some present **state** and some previously registered desired **state**.

This is a property of **regulators** and a basic feature of any **control system** or **subsystem**.

1168

ERROR CONTROL²⁾

The compensation of any **process deviation** that could lead the system to an **instability threshold**.

The control of errors by **feedbacks** was at the origin of cybernetics. It aims at **dynamic stability** in **processes** and systems by maintaining their **fluctuations** within predefined **limits**. It was discovered and practised empirically various centuries before the theoretical work of N. WIENER.

Error control is obtained through the iterative **measurement** of errors, used by the control device as **data** to determine by comparison with the established **stabilization standard** the needed counteractive **action**. See: "**control by error**".

1169

ERROR CORRECTING CODE²⁾

In a **communication device** "An **encoding code** which corrects **messages** that contain **transmission errors** of up to a certain number per **message**".

K. KRIPPENDORFF, author of the definition, states that "A code is error correcting only if the **HAMMING distance** between the **messages** sent, exceeds twice the number of transmission errors per **message**" (1986, p.28).

1170

ERROR DETECTING CODE²⁾

In a **communication device**: "An **encoding code** which correctly identifies **messages** that contain **transmission errors** of up to a certain number per **message**, without the ability to correct them."

K. KRIPPENDORFF, also author of the definition, again adds that: "A code is error detecting only if the **HAMMING distance** between the **messages** sent, exceeds the number of **transmission errors per message**" (1986, p.28).

See "**HAMMING distance**".

1171

ERROR SIGNAL²⁾

The difference between the reference **value** of some controlled **function** and the **value** observed by the **control system's comparator**.

The **perception** of an error signal triggers a specific correction, but only through a well constructed **regulator**.

Alternatively W.T. POWERS describes it as a signal that "produces an **action** that tends to correct the error" (from POWERS homepage).

"If the **control system** is very sensitive to small errors, it won't take much of an error to produce an **output** large enough to prevent any further **drift**..." (Ibid)

In fact, the basic point is about the degree of **complexity** of the **environment**, as related to the system.

In a thermostat, the error signal is obtained from a very simple device measuring a unique well defined **variable**, easy to install and to organize for perceiving specific **inputs**.

In a human driver - the example given by POWERS - the error signal becomes much more complex in itself and supposes an also highly complex integrated regulator: the **nervous system**, including the whole of the **neural network** in the **brain**.

1172

ERROR-FREE REPRODUCTION^{1) – 2)}

Error-free reproduction is possibly the main problem for **complex systems**, in which not only **structures** and **functions** must be maintained, but altogether, in H. ODUM's words: "There is the additional work of maintaining an error-free **plan** or generating an improved plan by combining extra **reproduction-generating choice** and **selection**..." (1971, p.142).

Error-free **reproduction** is not **free**. It demands an extra cost in **energy**.

1173

ET CETERIS PARIBUS^{1) – 3)}

This well known latin quotation whose **meaning** is "other things being equal" is in fact the banner concept of **linear causality**.

It is of course a pure **abstraction**. **Context-free situations** do not exist. There is not one single natural sequence of **events** in which all "other things are equal". It is also unsound to postulate the **identity** of two merely **similar situations**. They only should be **compared**, which of course leads to discover not only their **similarities**, but also their **differences**.

"This *ceteris paribus* limitation account for the inability of otherwise able analysts to develop meaningful **scenarios** for the future. It is a source of serious problems in **risk management**" (I.I. MITROFF and H.A. LINSTONE, 1993, p.126).

Nevertheless, the **linear causality** concept remains very useful to obtain functional laws and principles that can be used *within limits of validity that must be established*.

Models thus constructed on a **linear** causal basis should be considered either as approximations whose use must be qualified, or as formalisms of some specific type.

1174

ETHICS AND MORALITY ¹⁽⁴⁾

Heinz von FÖRSTER wrote in a letter to Monika BRÖCKER "As you know, it is for me of decided importance to separate ethics and morality once and for all. Morality is characterized, as you will remember, by two points. The first being that every statement, every **rule**, every law of morality is directed to the other. The decalog is a good example: "thou shall not kill", "thou shall not covet thy neighbor's wife", etc. etc.

The second point being that the authorities, that postulate these laws, are themselves not subject to these laws" (H. von Förster & M. Bröcker, p. xix, 2002) (In the German original)

About the first point, von Förster observes that it reflects the **self-organizing** nature in any society. And as to the second point, enforced obedience is the **mechanism** that forever in the past guaranteed the **maintenance** of self-organizing society.

However when it comes to ethics, von Förster is generally quite elusive: "Ethics is implicit in what I say". Which apparently means ethical **responsibility** is not merely to comply with rules by obedience, but to decide for oneself what should be said or done, i.e. to take the full personal responsibility for one's **behavior** and **actions**. von Förster concludes: "I just remembered that perhaps the best analogy to the problem of speaking about ethics appears in Chinese philosophy, where they have the difficulty of speaking about the Tao" (Ibid) and "Ethics do not contain guidelines" (p. 14)

It could possibly be said that morality is compulsive within a prescriptive view of an **auto-poietic** society, while ethics delegates **decisions** to individuals endowed with a deeper **understanding** of their relations within society whose global survival is the only guarantee for everybody's personal survival.

And, after quite - long soul- searching, Heinz von Förster concludes "Ethics is the **behavior** with which I make myself responsible for my **actions**" (p. 49, 2002)

The known psychiatrist and logotherapist Victor FRANKL considers that "moral" can survive only if it becomes rooted in existential and **phenomenological** experience. This is again transfers us from a **top-down** autocratic concept of morality (implying mere passive compli-

ance) to a **bottom-up** constructive ethics based on individual and personal evaluations of the effective or potential consequences of one's own **behavior**.

Even so, it is still very probable that such evaluations will be tainted by psychological **constraints** of **cultural** origin and even group membership (the much praised "esprit de corps" or "spirit of the hive")

The whole matter remains, even in systemic terms, an elusive conundrum.

→ **Autopoiesis; Commons; Conversation; Decision making; Free will**

1175

ETHICS as related to Mindscales ⁴⁾

Ethics has been defined as the "science of the **oughts**" (A. BAHM, 1992)

But to make it a "science", we would need precise criteria about the way these "oughts"-should be defined, which is of course quite difficult.

According to M. MARUYAMA (1994, p. 125-6) the ethical attitudes are quite diverse and become established on the basis of the very different mindscapes dominant in distinct **cultures**.

He thus distinguishes the following basic ethic pronouncements by the representatives of the four basic psychomental types he describes:

- the H type (homogeneous, hierarchical) considers that "the stronger should dominate the weaker" (thus "order reigns")
- the I type (heterogenist, randomizing) thinks that "everybody should be self-sufficient" (- being poor is a person's own fault")
- the S type (heterogenist, cooperative) believes the "different individuals should help one another" (Harmony should be sought and maintained)
- the G type (heterogenist, co-creative) vows that "New diversity should be generated" (Change is good and should be sought for")

Of course these divergent views are the main cause of the eternal and labyrinthic search for an ethics acceptable by everybody.

Maruyama applies the same views to aesthetics (Ibid, p. 126-7)

1176

ETHICS (Normative) ⁴⁾

G. MINATI considers normative ethics as "a self-designed social **software**", or "social self-designed **space** of **rules** in which social systems behave" (2002 a)

In such a **process** **agents** and **collective beings** behave giving rise to new processes of **emergence** affecting both natural **environment** and current social ones".

And "This social space of rules strongly influences **behaviors** of collective beings, i.e. available, used **cognitive models**".

These views, while seemingly meaningful, would need some clarifications:

- could "Collective Beings" be assimilated for example to **rule-bound human systems**?
- How exactly do agents insert themselves in "Collective beings"?
- How does this **metalevel** ruled space arise out of interrelated agents actions? Could for example the **network model** be useful and how?
- What could be the **role** of "cognitive models" in "**cultures**"? Or are cultures implicit "cognitive models"?

As to "ethics", if "normative", it is very different to the personalistic ethics of von Förster, for example.

→ **Autopoiesis; Closure; Ethics and Morality; Morality; Semantics (General)**

1177

ETHICS OF TECHNOLOGY CREATION ¹⁽⁴⁾

This very important issue does not yet seem to be considered with a sufficiently serious attention.

To all of the technological developments of the 20th century, the following words of A. BEDAU can be applied: "The development of a powerful new technology usually has ethical consequences. Atomic fission and fusion provide examples from recent history, and today genetic engineering threatens to teach us this lesson again. The havoc wreaked by computer "viruses" and "worms" provide ample evidence of the destructive power of artificial life technologies; precautions must be taken against their accidental misuse and intentional abuse" (1996)

Bedau could have cited numerous other examples: military uses of aircrafts, uncontrolled use of pesticides, imprudent use of antibiotics, etc.

In fact, the issue is very complex:

- 1) The discoverer generally feels that he is making a very positive contribution, specially if he/she is a scientist
- 2) He/she quickly loses control on the derived technologies
- 3) Psychological and sociological factors (greed, lust for power, and even pure irresponsibility) introduce undesirable and unethical deviations in the technological applications
- 4) When the "genie already escaped from the bottle" there is usually no way to put it back in it.

The subject should deserve a systemic **inquiry** into the deeper mechanisms of the whole **process** using for example **models** like **small-world** propagation, **bottom-up** and **top-down** processes, **competition**, **awareness**, **norms** and **values**.

The crucial question mark seems to be:

- Why is there such a difference between what ought to be and what happens in fact?

- What could be done about unexpected **side effects** and **delayed effects**?
 - How could personal **responsibility** be enhanced by social education, i.e. how could individuals be made fitter as members of their society?
 - What could be done to better **forecasts** about technological side effects?
 - What kinds of **regulations** and/or **controls** could societies establish to avoid negative effects of technologies?
- ...and how to avoid in turn, negative effects of these legal (or other) devices?

And last, but not least, how could ethical or unethical **behaviors** derived from technology be accurately assessed and valued, and by which social arbiters?

In short, this issue is overriding and a major systemic issue

1178

ETHICS (Systemic) ^{1) - 3) - 4)}

"Code of conduct and responsibility that **agents of change** ought to follow when designing systems" (J. van GIGCH, 1978, p.590).

van GIGCH states: "The ethics of systems is concerned with the **values** held by the planners and the designers of systems and the consonance of these **values** with those of the recipients. These issues also revolve around the problem of obtaining **consensus** for the implementation of systems acceptable to all" (p.75).

However, this is still the "ought of the ought". Besides, general acceptability is necessary, but *not sufficient*. While in systemic ethics, **values** are basic, so are however, *for all stakeholders*, sound **knowledge** and **understanding** of why the **situation** is as it is, and which are the real (i.e., factual, not merely based on idealism or **ideology**) possibilities to modify it, if needed. No sound systemic ethics is possible without well informed **understanding**. In this century, we constructed many hells paved with good intentions. In this sense, see for example J. WARFIELD on **Global Design** and **underconceptualization**.

van GIGCH himself takes good care to study what he calls the "ethics of spillover **effects**". He shows how advantages and disadvantages of any **change** should be pondered. He also defines a comparative ethics of **goals** and extends himself to the ethics of social responsibility and general conservation. He ends up with some reflections about the "realist versus the idealist" (p.145-68).

The crux of systemic ethics is that, notwithstanding some important contributions, their precise content has not yet been clearly expressed, nor unanimously accepted.

According to A. BAHM (1992), ethics is the "science of the ought". **Systemics** do indeed reveal some aspects of general **organization** (in **ecosystems**, in **sociosystems**, etc...) which formerly were widely ignored or undervalued.

In this perspective, some disorganizing **activities**, even when unwittingly pursued, may be judged unethical. We should become aware of our new **responsibility** to manage **organizations** and natural and artificial systems in non-destructive or damaging ways.

It becomes obvious that such **situations** cannot be correctly (i.e. ethically) managed without a good **understanding of complexity**. The systemic view thus amplifies our ethical commitment by introducing a critical new dimension to our worldview.

While until now ethics related only to **relationships** among humans, it becomes now urgent to extend it to a concern for life in general in an **ecological** perspective, would it even be merely to maintain the **survival** potential of mankind itself and of many human **groups** in particular.

J. van GIGCH formulated the basics of what he calls "Metaethics" (1990). He thus distinguishes three ethical **levels**:

1. The inferior **level**, i.e. the user's one, i. e. of individual **rights** and duties, regulated through legal **rules** and **norms**;
2. The normative **level**, established by theologians and social scientists, wherein **concepts** like "good", "bad", "correct", "incorrect", etc... are produced in relation to **behavior** standards;
3. The metalevel, where **epistemological** and logical aspects are considered and ethical judgements are evaluated as "true" or "false".

Even at that upper **level**, we still need **criteria**... and mankind accelerated **evolution** itself tend to extend these **criteria**. Metaethics should corresponds to **metasystems**.

Some very general tentative systemic ethical principles may be formulated in the following ways:

- What is good for the system should also be good for its **parts**.
 - No **part** has the right to inflict damage to the system to which it belongs.
 - What is good for the system should not be nocive or destructive for the **metasystem**, or **subsystems**.
 - What is good for the system should not be nocive or destructive for another system.
 - Act always so as to increase the number of **choices** (von FOERSTER).
- Systemic ethics should also explore the following ethical problems:
- What are the limits of the system's right to fight for its **survival**? Which **criteria** should be established and by whom?
 - Has the system the right to destroy one of its **parts**, if dangerous for its own **survival**? Which **criteria** should be established and by whom?

Systemic ethics is thus many-dimensional, including bio-ethics, ecological ethics, economical ethics, socio-ethics, etc., all of which becomes translated into the ethics of personal **behavior**, and also should become integrated

in the law system, both in law itself and in the judge's ethics, who, apart of a purely legal viewpoint, should take responsibility for the positive and/or negative consequences of his/her decisions (E. GRÜN, 1995, p.66).

Systemic ethics is becoming an urgent must in an ever more complex and integrated world and should be applied to ecological, economic, political, social and scientific research **situations**, if gigantic disasters are to be avoided.

With the progressive self-construction of a **man-planet system**, the relations between individual and **groups** ethics with a planetary eco-ethics start to loom larger and larger. The following comments by G. HARDIN help to make the point:

- "The disadvantages of each new intervention in the web of life increase with **population** size (1976, p. 65)
- "One of the principal aims of the **automation** is to purge **control** systems of ego (p.105)
- "Beyond the limits of his confining skin, no man can own *anything*. **Property**" refers not to things owned by the rights granted by society; they must periodically be re-examined in the light of social justice (p. 127)
- "We are not free to violate the laws of nature. We become free when we recognize their necessity"(p. 132)

This last comment becomes crystal clear in systemic terms with the following quote:

- "The morality of an act is a function of the state of the system at the time the act is performed"(p. 134)

Of course, there are at least two fundamental difficulties arising from HARDIN's "ecological ethics":

1. A satisfactory **knowledge** and **understanding** of the "state of the system"(at village, or at planetary level) is quite difficult to obtain individually, still more difficult to reach at the **community level**...and still more so at the global mankind level
2. Naked greed is in most cases a much more powerful motive than yearning for common good. An it leads ultimately to global mankind **parasitism** on its cosmic home

Both factors could easily become the ingredients for global disaster

1179

ETHNOCENTRISM ^{1) - 4)}

The prevalence of a type of **mindscapes** and of its bearers in an **organization** or in a **culture**.

It is quite normal, probably inevitable, and possibly necessary that a system of **values** and **norms**, reflected in **mindscapes**, be predominant in any organized **human system**. It can be equated with a specific **order parameter**, in accordance with H. HAKEN **slaving principle**.

The problem is that it leads frequently, through ignorance or scorn of other **values** or **norms**, to serious mistakes, abuse, oppression and even cruelty.

Ethnocentrism as a systemic **problem** is widely explored by M. MARUYAMA (1994, p.42-5).

→ **Technocentrism**

1180

ETHOLOGY¹⁾

The science of animal **behavior**.

Ethology brought very significant contributions to the general store of systemic concepts and **models**, the most important listed hereafter:

- A better **understanding**, by comparison, of human **perception**, by demonstrating that the **observation** windows of different animals are far from being similar to those of men. **Perception** is conditioned by sensory sensibility (for example to infrared or ultra-violet radiation, or capacity to perceive or not some sounds, etc.). It also depend on size, stature and position, which is important when comparing children and adults **perceptions**.
- A keener understanding of **living systems'** individual as well as collective **interrelations** with their respective correlated **environment**. See f. ex. "**stigmergy**".
- More recently, by the study of social insects, through the **understanding** of the nature, workings and implications of **communication** for **sociality** in living beings and, possibly in the future, of societies of artificial **organisms**.

The most important school of ethology has been the German one (Bibliography: von UEXKÜLL, KRISZAT, LORENZ, EIBL-EIBESFELDT). Insect ethology is recently more of an Anglo-saxon concern (T. SEELEY, J. and C. GOULD, E.O. WILSON, W.C. ALLEE, D. GORDON). African primates have been studied by J. GOODALL, D. FOSSEY, F DE WAAL and others.

According to REVENTLOW (1973)- as quoted by S. BRIER (1992, p. 75): "As ethology demands that animal and human **behavior** be examined in relation to their **biotopes** and at all times strives to understand psychological **phenomena** on the basis of the **relationships** between **stimuli**, **motivation** and behavior, ethology becomes one of the broadest psychological theories in existence-and certainly the most ecologically oriented

"In lieu of "theories", it would possibly be better to speak about " observation tools". Indeed, Brier makes the point quite clearly in his paper.

1181

EUSTRESS⁵⁾

The excitement that accompanies an appropriate degree of personal challenge (R. NUMMELA CAINE & G. CAINE, 1994, p. 72)

H. SELYE himself, who introduced the notion of **stress**, duly expressed that **stress** can be a positive as well as a negative **reaction**. He even invited his readers to enjoy the stress of life!

1182

EVALUATION in systemic terms^{1) - 3)}

The **process** of verifying whether a system performs as expected.

The crux of the matter is to define what *should be* expected of the system.

In many cases what the **evaluator** expects is not what the system is able to offer, because she/he does not really understand its workings and its production conditions.

The evaluator should thus begin by questioning her/his proper **knowledge** of the system and **validity criteria** of expectations.

1183

EVALUATION LOOP (Self-)²⁾

This **brain** feature is proposed by the French neurologist J.P. CHANGEUX, according to whom such loops: "cut the reward **signal** coming from the outside world and allow a "tacit" testing of motor intentions, on the base of the memorized traits of a former experience" (1992, p.712).

This seems quite close to H. MATURANA's concept of **self-reference** and **organizational closure**.

It is even probably a quite more general property of **networks** of any kind.

1184

EVALUATOR²⁾⁴⁾

A device within an **adaptive system** that "calculates an estimate of the "distance" of any given situation from the **goal**"(J. HOLLAND, 1992, p.48)

The evaluator needs to receive **information** from **detectors** about the results of the most recent **actions**.

HOLLAND observes: "There is however a caveat. If the set of detectors is inadequate, for whatever reason, the improvement of the evaluator will be blocked. This raises the broad issue of **pattern recognition**, for the **set** of detectors is, of course, meant to enable the (genetic adaptive) plan to recognize critical features for **goal-attainment**" (Ibid).

HOLLAND also offers adequacy criteria for detectors: "The estimates are supposed to take the costs of the **transformations**, etc., into account; that is, the "distances" are usually weighted **path** lengths, where the paths in-

involved are (conjectured) sequences of transformations leading from given **situations** to the goal. The intent is to use these estimates to determine which transformations should be carried out next. An evaluation is made of each of the situations which could be produced from the current one by the application of allowed (simple sequences of) transformations, and then that (sequence of) transformation(s) is executed, which leads to the new situation estimated to be "nearest" the goal." (Ibid)

Evaluators are an essential part of any **adaptive system**, from biology to business and artificial life devices.

1185

EVENNESS²⁾

A measure of **diversity** in some defined **space**

C. WILLS writes: "If a minority of species in a quadrat are common and the rest are rare, it is considered to have low evenness. But if, in another quadrat with the same number of species, all the species are equally common, then the quadrat's evenness is high" (1996, p.42)

1186

EVENT¹⁾

1. "A point in **space-time**, precisely localized by its three spatial coordinates and its time coordinate" (J.P. LUMINET, 1987).

2. "A **change** in one or more structured properties of either an **object**, a system, an **environment** or a **relationship** between them over a **time period** of specified duration" (R.L. ACKOFF & F.E. EMERY, 1972, p.25).

LUMINET comments to his most general definition that "the separation between two events remains absolute, whatever reference system is used".

In accordance with ACKOFF and EMERY definition, an event must frequently be an unforeseen happening.

From a very basic viewpoint, G.L. FARRE expresses that "events are the traces left by these **transformations**"(i.e. of **energy**)

As energy acts at different **levels** in nature, we have gravitational, chemical, electro-mechanical, biological, or microphysical and **quantum events**.(1998b, p. 262)

An **event** does not always fit into the sequence of **situations** which seemed possible within the formerly forecasted or awaited ones. As stated by J.van GIGCH, unique events, far away from standard statistical **deviations**, can be enormously important (1978, p.212).

In the study of a **complex system**, it obliges us to question our **knowledge**, or at least the **model** that we had formerly built.(in an explicit or implicit way).

Such failures in **forecasting** are generally results of:

- the ignorance or disregard of some basic aspect of the system or its **interactions** with its **environment**;
- the ignorance or misappreciation of the irreducibility of **long term transformations** to **medium or short term** ones.

3. For the French biologist J.P. CHANGEUX an event is "Any modification in the **environment** or of the system itself that may modify its **dynamic stability (Homeostasis)**" (1972, p.37).

CHANGEUX's definition refers only to **living systems**. It seems however that it can be applied to **social systems** and, possibly in the future to artificial **distributed intelligent systems**, if it becomes possible to endow them with the ability to modify their collective **behavior** by **learning** through **behavior rules**, without any rigidly imposed **algorithmic control**. (see "**Artificial Life**").

Following this definition, the event may oblige the system to *create* a new **response** (i.e. to learn) and not merely to cross-over from one **state** to any other, previously visited or known.

From a **constructivist** and physio-psychological viewpoint, in R. FISCHER words: "... **environmental events** are specified as internal **states** that are - in mammalian **brains** - the neural system's own **symbols**, as these **states** stand in regular relation to events in the world and signify potentials for **action**" (1992, p.219).

An event can be destructive if the system does not discover some efficient **response** to it. It may also lead merely to a broadening of the system's **states repertory**. In this case, the system maintains its **organizational closure**.

As a third possibility, the system could be so radically modified by the event that its basic **identity** becomes altered. This could lead to **emergence** (if the event is a massive increase of **energy** supply), or to **evolution**, if the system's basic **organization** is altered by a nonlethal mutation.

1187

EVENT AND ELEMENT ^{1) - 3)}

E. MORIN writes: "a) The notion of element relates to a spatial **ontology**. The notion of event relates to a temporal **ontology**. Now, any element may be considered as an event if viewed within **temporal irreversibility**, as a manifestation or actualization, or in **function** of its singularity. **Time** impose an "eventuality" coefficient to anything".

b) In other words, ambivalence reigns always between event and element "while there is no "pure" element (i.e. any element is **time-binded**), there is also no "pure" event (it always relates to a system) and the notion of event is relative".

c) Still in other words, "... the accidental, aleatory, unlikely, singular, concrete, historical nature of any event depends from the system under which it is viewed. A same **phenomenon**

is event within some system and element within another. Example: traffic deaths during week-ends are predictable and probable elements within a demographic-statistical system, which obeys strict laws. But each one of these deaths is, for the members of the family, an unexpected accident, a misfortune, a concrete catastrophe" (1972, p. 17).

1188

EVENT-BASED EPISTEMOLOGY ³⁾

H.von FOERSTER observes: "**Objects** and events are not primitive experiences. "**Objects**" and "**Events**" are **representations** of **relations**" (1992, p.265).

This has also been shown by A. KORZYBSKI with his "**structural differential**" (1933, 1950, p.386-411): we all must start from "something out there", but we only can make sense of it in *our own* perceptive and conceptual terms. Thus any "event" is already no more than a more or less accurate and efficient *fabrication*.

This appears clearly when, in a different sense, M. Mc WHINNEY and D. BUSHNELL emphasize that: "Classificatory **epistemologies** are derived from **observation** of systems in **equilibrium**, thus they organize **knowledge** in accord with normal **distributions** of **matter** and **energy**, ones that present the "typical" **distribution** of explained **phenomena**. Such is the foundation of contemporary sciences, social as well as natural" (1987, p.291).

In other words, we mostly live on an epistemology of **stability**, or at most **dynamic stability**. But this blocks effectively our **understanding** of any kind of system that does not conform with this **model**.

Thus the cited authors propose: "Systems practice in an era of turbulent **change** calls for an "event-based" approach to **understanding**. Such an approach to establishing **meaning** recognizes that **emergent systems** have unique properties, not predictable from the **behavior** of **component subsystems**. Thus extent **classification rules** inappropriately filter out new or highly unusual **phenomena**. An event-based **epistemology** provides a better basis for **understanding behavior** in **dissipative (self-organizing)** systems which operate far from the presumed **equilibrium** conditions. This is true of all **dissipative systems**, but we see the effects especially in those that are directed by sentient and **purposive** beings" (p.291).

The lack of such an epistemology hinders gravely our **understanding** of the present massive **transformation** of mankind, which is probably on its way to global **integration** at planetary **level**.

1189

EVENTS as percepts ³⁾

An event is basically the **perception** of a **change**, or a **distinction** between a former and a later **state**. It is not clear if we perceive events through **time flow** or **time flow** through the succession of events: In J.J. GIBSON's words: "Events are perceived, but **time** is not" (1986, p.100).

Another intriguing aspect is that events are perceived in function of a more or less stable **background**.

Furthermore, the events that are perceived depend on the **time-scale** of each perceiving system. Events for a caterpillar or a mosquito are those which occur within the reference **time frame** of a season. Human beings are able to perceive some events on a yearly **scale**, and even with more abstract insight, on a geological **scale**.

Any event is inscribed in a specific **space-time frame**, related to a specific class of **observers**.

1190

EVENTS (Structural class of) ^{1) - 3)}

"A **set** of events that consist of similar **change** of the same **structural** properties" (R.L. ACKOFF & F. E. EMERY, 1972, p.25).

This is a very general concept, allowing for the construction of **transdisciplinary models**. A good example of such a **structural class** are R. THOM and E. ZEEMAN "**catastrophes**". **Bifurcations**, **threshold crossings** or **dissipative structuration processes** are also structural **classes** of events.

According to ACKOFF & EMERY : "...the **cause-effect** and producer-product relations apply to events and to the concepts derived from them".(Ibid).

1191

EVOLUTION ^{1) - 3)}

The accumulative **transformation** of systems undergoing **irreversible changes**.

Evolution is a **global process**: Any **change** in some **part** of a system inevitably evokes correlated **changes** in other **parts** until a new type of **dynamic stability** is attained... if ever!

Evolution seems to correspond to a very general **trend** in nature tending to shape **open algorithms**: biological, but also behavioral and even technical ones.

By *open* it is meant: having the potential to produce **emergent** and radiating **levels of organization**, nevertheless necessarily based on the formerly established ones.

It should never be forgotten that "evolution" is a concept. W. REEVES writes in this sense: "Evolution is a general way of conceptualizing the **self-organizing selection process** of the universe displayed in the increasing **complexity** which occurs as a result of the dynamic bal-

ancing effort of **entropy** and **negentropy** through the **process** of **fluctuation**, **amplification** and subsequent **bifurcation** allowing successful **phase transition** and **emergence**" (1992, p.1102).

Many definitions more or less at variance with the proposed one are used by biologists, paleontologists, anthropologists and sociologists.

In any case, it seems basic to understand that *individuals* do not evolve: they merely adapt in accordance with their genetic inheritance, characterized by their **organizational closure** (in very unfrequent cases, affected at its very beginning by some mutation, which introduces a measure of **randomness** in the **process**). On the contrary, **populations**, species or societies evolve, as connected **wholes**, but through their individual members, who act as possible **transmitters** of **changes**, eventually inhibited, limited or favored by circumstantial **environmental** conditions. This again is in part a stochastic **process**.

H.G. BURGER expresses it in this way: "... all types of evolution... consist of a rivalrous **polymorphism** that awaits **environmental change**" (1967, p.209).

A. LOTKA's discussion, in 1924, maintains still its validity, specially in systemic terms. He stated in his chapter on this topic: "Evolution is not a mere changeable sequence... (this) is insufficient to define the *direction* of evolution.

"... the thing to mark is that what has imparted to the **process** its directed character is frictional resistance, **dissipative** forces, typical **irreversible effects**, to speak the **language** of the physicist...

"... such internal **changes** in a material system... lag behind the determining external **changes**" (1924, p.22- 26).

LOTKA bases thus his views of evolution on his **understanding** of **irreversibility** and of the ambiguous character of the concept of **reversibility**: to obtain **reversibility** (this is, a return to a *previous* condition), a **process** of (*timely*) **change** of the condition of the **function** or system is necessary. Thus, while some **states** of a system, or values of a **function** may be *repetitious*, is it confusing to qualify them as "reversible".

LOTKA concludes: "The law of evolution is the law of irreversible **transformations**; that is, the *direction* of evolution is the direction of **irreversible transformations**. And this direction the physicist can define or describe in exact terms. For an *isolated* system, it is the direction of increasing **entropy**. The law of evolution is, in this sense, the **second law of thermodynamics**" (p.26).

He observes that this is in accordance with CLAUSIUS since the Greek word from which he derived '**entropy**' precisely means 'evolution'.

Let us however observe that he also writes: "... we should constantly take in view the evolution, as a **whole**, of the system (**organism plus environment**)" (p.16).

Still more generally, he parallels evolution with a "**law of maximum energy flux**", meaning that still unused **energy** is the power house of evolution and implying that it tends to transform free **energy** into higher **levels** of **organization**.

As PRIGOGINE demonstrated many years later, there is no contradiction between the *general* increase of **entropy** and the *local* increase of **complexity** in systems, by **structuration** through **energy dissipation**. PRIGOGINE even sees this feature as the basic operative way in evolution: **instability** induced through growing **fluctuations** → increasing **dissipation** of **energy** → **threshold** → **bifurcation** → **emergence** of new and more complex **forms**.

In E. LASZLO's words: "Evolution... exploits **energy-flows** which possess inherent **stability** in certain highly specific **configurations**. It takes place in **open systems** with **inputs** and **outputs**, whereas the **laws of thermodynamics** apply to **closed systems**" (1974, p.206).

LASZLO synthesizes his views as follows: "... separately investigated branches of evolutionary disciplines... disclose a dynamic that is **isomorphic** in its essentials with the **nonlinear dynamics** of **bifurcations** in the **complex system** investigated in **nonequilibrium thermodynamics** and dynamical systems theory" (1993, p.113).

Of course, the **laws of thermodynamics** apply also to **open systems**, but in a different form. See: "**Entropy production in a system**".

The concept of evolution through use of intrinsically well configured **energy flows** (in *fields*?) is quite close to LAVILLE's concept of form shaping through **energy vortexes**, or D. Mc NEIL's **toroids**.

Evolution seems to be related to:

- **Adaptability** in **self-organizing** systems by reaction to environmental **noise** through **random** mutations some of which prove to possess adaptive value.
- **Interaction** among such transformed **self-organizing** systems, which then react reciprocally within the **constraints** of their common **environment** and eventually (but not necessarily) diffuse their new characteristics. H. LABORIT writes: "...it is difficult to conceive that evolution could occur only by **random** reorganization of the **interrelations** within a **set**, but more easily by **addition** of new **elements** to this **set**, by way of its intersection with another **set**" (1972, p.114).

P. WINIWARTER and C. CEMPEL thus summed up the general characteristics of **macro-level** evolution, as applicable to technology:

"1) A **global optimization** of **energy flows** (load **optimization**) for a **set** of "running" or "living" units;

"2) **Design** or **code modification** for the next generation of units (**adaptation**);

"3) Re-design, complete recoding or **code-creation** for an entire new technology (evolution)" (1992, p.32).

Still another interesting insight on evolution is D. LEPINARD's: "The evolution of the **behavior** of **cells** and animals through **time** can be understood as a progressive rolling up on the causal chains. Living beings tend more and more to stand back on vital acts, like eating or mobilizing **energy**" (1993, p.25).

In other words, **processes**, **perception** and **memory**, and in man's case, increasing **understanding** of the past allows for a growing internalization and **control** of vital **processes**, which could define the "arrow" of evolution.

However, evolution is also an accumulative **process**: once a really basic evolutive groove has been traced, it becomes fixed and is used as a baseline for further **development**.

Finally, quoting P.M. ALLEN, K.DE GREENE makes the following very basic observation: "Newtonian mechanistic systems can only function; they cannot evolve... The Newtonian **machine** cannot restructure itself or insert new **components**. It appears the **cybernetic/servo-mechanism** systems are just such Newtonian **machines** that can only function and that cannot generate the **emergence** of qualitatively new properties" (1994, p.7).

This comment can be extended to **Hamiltonian mechanics**. It explains why the **mechanistic-reductionist paradigm** is in need for the complementary systemic one.

1192

EVOLUTION (Co-) ^{1) - 4)}

Changes in a system and/or its environmental **co-systems**, as a result of reciprocal **action**, producing an evolutive **feedback process**.

According to R.N. ADAMS: "Co-evolution emerges when two or more **sets** of **energy** forms interact so that each becomes dependent for **survival** and evolution on the other. Co-evolution effectively blends the **process** of competitive Darwinian **selection** with the **environmental selection** of WALLACE" (1988, p.130). He adds: "The significance of co-evolution as a **process**, however, is that the **trigger - flow interactions** specifically create an *interdependent reproduction* among the participating **dissipative structures**. It interlocks a series of separately reproductive systems into a single interactive reproductive system" (p.133).

Co-evolution supposes permanent **interactions** between **flow lines** registering and transmitting **information**.

K.DE GREENE states: "Over **time** systems and **environments** co-evolve,... system's **changes** impact the external **environment**, and **changes** in this **environment** impact the

system. For organic **evolution** as a whole, **populations**, species, genera and families maintain **congruence** or **fit** with their **environment** over considerable **periods**. **Regulation** and **control** stem from the system-**environment relationship**" (1988, p.251).

DE GREENE proceeds by explaining how, in human systems, the co-evolution **interrelation** between system and **environment** is modified by **management**. In fact, as observed by H.J. and I. JERISON: "The **organism**, by its **actions** and preferences, partly selects the **selection** pressure which will act upon it and its descendants" (1980). This seems to have been true at least since the creation of an oxygen atmosphere by old and simple living beings.

Man however, having a more or less developed **understanding** of the **relationship** between his systems and their **environment**, tries (and is more and more able to do so) to modify it voluntarily, and even sometimes willfully. Moreover he does it mostly to obtain **short term** results in a supposedly **positive sum game**, ignoring **long term** results which may lead to "unchecked decay", in J. WARFIELD's words (1987, p.230).

Considering that, in E. JANTSCH words: "Coevolution is the generating principle of macrosystems, at least in the **domain** of life, but thereby a "vertical" dimension of coevolution is also implied by the coevolution of the macrocosmos and the microcosmos, the mutual enhancement in the evolution of **macrostructure** and **microstructure**" (1982, p.347). A better **understanding** of co-evolution, specially between man (the planetary super-predator) and the **biosphere**, is thus very important in order to avoid mega-disasters in the future of mankind. See for example the case of the Aral Sea, considered in systemic terms (CH. FRANÇOIS, 1989, p.1101-11).

St. KAUFFMAN observes that "... coevolutionary **changes** tend to occur in bursts followed by **periods** of quiescence" (1993, p.269). This rejoins S.J. GOULD and N. EL-DREDGE theory about intermittent and punctuated evolution (1993).

Co-evolution is now actively researched, using adaptive **automata**. One example is the **modelling** of the predator-prey evolving **interactions** leading to **adaptive transformations** in the **behavior** and the internal **controls** themselves of the automata. This research takes place at the Ecole Polytechnique Fédérale de Lausanne (Switzerland) (D. FLOREANO, 2002, p.24-28)

An important aspect of co-evolution is that it also implies co-extinction. This **phenomenon** is generally overlooked. It is however becoming now very frequent. For instance, the **destruction** of enormous tracts of tropical forests

leads, as a corollary, to the destruction of the **habitat** of a great number of vegetal and animal species. Many of them are condemned to extinction as a result.

→ **Evolutionary robotics; Red Queen evolutive parable; Selection in populations (Combinatory); Selection principle (Loop)**

1193

EVOLUTION (Energy cost of) ¹⁾

H. ODUM states: "In evolution, not only are the **structures** and **patterns** of the systems maintained against the disordering influences through duplication, **selection** and loopback currency, but, by definition of the term, novel **changes** are made. The power cost of the **change** is the power cost of making even more **choices** and **selections** than are required to hold the order stable" (1971, p.151).

This implies that any important evolution step supposes the existence of still unused **energy**, which allows for the shaping of some new type of system able to take advantage of it.

An extraordinary example is the explosive evolutive **structuration** of human societies since the discovery of new ways to use coal, oil and gas as sources of **energy**.

1194

EVOLUTION (Energy flow and) ¹⁾

A. LOTKA formulated an hypothesis according to which the essential logic of evolution corresponds to the maximal use of the available free energy.

He surmises that the planet as a whole is an energy **dissipative system**, under the guise of what he calls the "**world engine**". This latter would be a global system endowed with multiple **correlations**, being an integrated **set** of numerous coupled **energy transformers** (green plants, plankton, herbivores, carnivores) able to use maximally the global energy flow.

According to LOTKA, the basic tendency of evolution is to improve this **transformation** line by eliminating the less efficient species and favor the most efficient ones. He made (in 1924) this suggestive prediction, placing man as the most powerful **energy transformer**: "...the problem of economy in husbanding **resources** will not rise to its full importance until the available **resources** are more completely tapped than they are today. Every indication is that man will learn to utilize some of the sunlight that now goes to waste. The general effect will be to increase the **rate** of energy flux through the system of organic nature, with a parallel increase in the total mass of the great world transformer, of its **rate** of circulation, or both" (1956, p.357-8).

1195

EVOLUTION Horizontal and Vertical ²⁾⁴⁾

Chr.De DUVE, the Belgian biochemist, Nobel Prize 1974, distinguishes two different evolutive ways:

Horizontal: which creates **diversity** by variations on some basic type. De DUVE states that there are millions of insect species, but all are variations on the basic corporal plan of insects.

Vertical: which modifies the basic plan, adding to its **complexity**.

(Interview of Chr.De DUVE by O. POSTEL VINAY, 1996, p. 92)

This concept is basically referred to biological evolution. It would be interesting to find out if and how it could be applied to the **emergence** of **sociality** at different biological levels, and what it could mean for cultural diversity in human societies.

1196

EVOLUTION (Laws of) ¹⁾

D. DUBOIS recapitulates as follows the basic laws of evolution (1990, p.121-26):

1. **Fundamental biological law**: Embryonic **structures** of more complex **living systems** diverge by progressive specification from embryonic **structures** of less complex ones (von BAER, 1828; Haeckel, 1866).

2. **Growing complexity law**: In general terms, evolution leads to the **emergence** of more complex species, principally through the acquisition of a more complex nervous system.

3. **COPE's law**: Any lineage of species starts with small generic ones endowed with all the basic characteristics of the phylum.

4. **Diversification law**: Evolutive bursts take place, producing "bushy" ramification of more precisely adapted species, which become dependent of specific **environments**.

5. **Size increase law**: Most types tend to evolve toward an increased **size**, frequently leading to gigantism which difficulties further evolution when important **environmental changes** take place (H. DECUGIS, 1941).

6. **Take-over Law**: Evolutive **cycles** repeat themselves for each innovative biological type (orthogenesis), leading to either favorable **adaptations**, or neutral, or unfavorable ones.

7. **Irreversibility law**: Evolution never backtracks. Archaic forms never reappear once eliminated (DOLLO's Law).

8. **Evolution speed law**: In any group, the evolutive **rhythm** decreases as the group becomes older.

One could possibly add one more law: Evolution is radiative, but historically constrained, i.e. new types appear only as **transformations** from former ones or, no totally new evolutive lines start ever from "scratch" (M.C. MARNEY and N.M. SMITH, 1964).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

These are biological laws, but one wonders if they could not be translated to the evolution of **organizations** and **sociosystems** wherein some very similar **transformations** seem to be occurring through **time**.

1197

EVOLUTION OF COMPLEX SYSTEMS BY AGGREGATION: SIMON's Hora and Tempus Parable^{1) - 2)}

H. SIMON explains through his famous Hora and Tempus Parable how **complexity** may have evolved:

"Let me introduce the topic of evolution with a parable. There once were two watchmakers, named Hora and Tempus, who manufactured very fine watches. Both of them were highly regarded, and the phones in their workshops rang frequently – new customers were constantly calling them. However, Hora prospered, while Tempus became poorer and poorer and finally lost his shop. What was the reason?

"The watches the men made consisted of about 1.000 **parts** each. Tempus had so constructed his that if he had one partly assembled and had to put it down – to answer the phone say – it immediately fell to pieces and had to be reassembled from the **elements**. The better the customers liked his watches, the more they phoned him, the more difficult it became for him to find enough uninterrupted time to finish a watch.

"The watches that Hora made were no less complex than those of Tempus. But he had designed them so that he could put together sub-assemblies of about ten **elements** each. Ten of these subassemblies, again, could be put together into a larger subassembly; and a system of ten of the latter subassemblies constituted the whole watch. Hence, when Hora had to put down a partly assembled watch in order to answer the phone, he lost only a small part of his work, and he assembled his watches in only a fraction of the manhours it took Tempus.

"It is rather easy to make a quantitative analysis of the relative difficulty of the tasks of Tempus and Hora: Suppose the probability that an interruption will occur while a part is being added to an incomplete assembly is p . Then the **probability** that Tempus can complete a watch he has started without interruption is $(1-p)^{1000}$ – a very small number unless p is .001 or less. Each interruption will cost, on the average, the time to assemble $1/p$ **parts** (the expected number assembled before interruption). On the other hand, Hora has to complete one hundred eleven subassemblies of ten **parts** each. The probability that he will not be interrupted while completing any one of these is $(1-p)^{10}$, and each interruption will cost only about the **time** required to assemble five **parts**.

"Now if p is about .01 – that is, there is one chance in a hundred that either watchmaker will be interrupted while adding any one **part** to an assembly – then a straightforward calculation shows that it will take Tempus, on the average, about four thousand times as long to assemble a watch as Hora.

"We arrive at the estimate as follows:

1. Hora must make 111 times as many complete assemblies per watch as Tempus; but
2. Tempus will lose on the average 20 times as much work for each interrupted assembly as Hora [100 parts, on the average, as against 5]; and
3. Tempus will complete an assembly only 44 times per million attempts $(.99^{1000} = 44 \times 10^{-6})$, while Hora will complete nine out of ten $(.99^{10} = 9 \times 10^{-1}) / (44 \times 10^{-6}) = 2 \times 10^4$. Multiplying these three ratios, we get: $1/111 \times 100/5 \times .99^{10}/.99^{1000} = 1/111 \times 20 \times 20 \times 20,000 \sim 4,000$ " (1965, p.65-66).

Two conclusions are obvious:

- a) **complexity** results from ordered **aggregation of elements**.
 - b) **complexity** is more easily obtained by fractioned **aggregation**, from **level to level**.
- And a third conclusion is tentative:
- c) evolution very probably proceeds by fractioned **level of aggregation** to produce **complexity**.

Another interesting comment by SIMON: "...we may be sure that the watchmaker's **metaphor** gives an exceedingly conservative estimate of the savings due to hierarchization" (Ibid).

Of course, fractioned **aggregation** is related to **hierarchy**, as a result from **competition** between systems, destined to become subordinated and to undergo **processes** of internal re-organization of their **structures** and **functions** to adequate them to their new settings.

1198

EVOLUTION (Process of)¹⁾

J.P. CHANGEUX, quoting D.T. CAMPBELL, thus resumes the general process of evolution, that seems to operate irrespectively of the concerned evolutive **level** (physical, biological, social):

"At each **level** some form of *selective retention* would operate by variation-**selection** with three basic elements:

- some **mechanisms** introducing variations, i.e. **diversity generators**
- coherent **selection processes**
- some **mechanisms** which would protect and spread selected variations" (1972, p.707).

This last **mechanism** is **recursive**.

Another very general and synthetic view of evolutive processes has been derived from biological evolution by W. SCHWEMMLER (1991, p.152)

This author distinguishes three basic stages in these processes:

- Arogenesis: a **phase** of innovative jumps
- Allogenesis: a **phase** of adaptive **radiation**
- Statigenesis: a **phase** of **stabilization** of the new types

This general concept is clearly akin to GOULD and ELDREDGE "punctuated evolution" (1993). According to SCHWEMMLER, such evolutive processes respond to a "**periodicity principle**", which he relates to the well known HEGEL's principle of "These, Antithese, Synthese".

1199

EVOLUTION THEOREM²⁾

"Every **concrete system** belongs to some evolutionary lineage".

This theorem has been enunciated by R. MATTESICH in his "Axiomatic representation of the systems framework" (1982, p.184).

1200

EVOLUTIONARY LEARNING COMMUNITY (ELC)⁴⁾

"A community that strives toward sustainable pathways for evolutionary **development** in **synergistic interaction** with its milieu"(K. BAUSCH-glossary, pers. comm., 2002)

This goal should be pursued "through individual and collective **processes** of empowerment and evolutionary **learning**. ELC's do not adapt their **environment** to their needs, nor do they simply adapt to their environment. Rather, they adapt with their environment in a dynamic of mutually sustaining evolutionary co-creation"(Ibid)

These views have been developed during the years 1996-2000 in Fuschl and Asilomar **Conversations**. As a general program, the ELC indicates a genuine systemic evolutionary **path** for human communities.

However the practical **meaning** and content (also in systemic terms) of abstract **concepts** like "sustainable path", "development", "empowerment" and "learning" should be seriously researched and clearly explained if the whole ELC concept is to become more than an expression of well-meant wishful idealistic thinking.

→ **Communities (types of human); Evolution (Co); SyntonyQuest**

1201

EVOLUTIONARY ROBOTICS²⁾⁵⁾

The study of the **processes** of **evolution** and **co-evolution**, using **automata**

This study tries to reproduce in automata the evolutive processes observed through the history of **living systems**, in darwinian terms

The automata are endowed with some quite simple behavioral potentials as for example the capacity to move in certain specific ways, or to perceive at some distance the presence of an obstacle, which can be fixed or moving

The results of each **automata's activity** are registered into an **array** of artificial **neurons**, which dynamically interact and may produce behavioral **changes** in the automata. This leads to a spontaneous process of evolution (and co-evolution) between two or more automata) This process may persist indefinitely in time. Some automata of this type can **simultaneously** undergo evolution in their **neuronal circuits** and their **morphology** (D. FLOREANO, 2002, p. 24)

→ **Artificial life; Epigenesis; Evolution (Co-); Machina Speculatrix; Parallel Distributed Processing; Self Organizing Systems; Selection**

1202

EVOLUTIONARY STABLE STATE ²⁾

A global state of a **set** of interrelated evolving systems such as their global **equilibrium** can not anymore be modified by any **change** in any of the systems.

This **model** has been created by mathematical biologists, in particular John Maynard SMITH (P. BAK, 1996, p.125)

It appears in Economics, as the "**Nash equilibrium**" and reflects a very general **situation** corresponding to evolutive blockage. However such apparently final **state** can be ruptured. But the conditions leading to a renewal of **evolution** are not yet clear.

→ **Co-evolution, Fitness, Frozen core, NK model.**

1203

EVOLUTIONARY SYSTEMS DESIGN ⁴⁾

"A form of **systems design** that responds to the need for a future-creating- design **praxis** that embraces not only human interests and life-spans but those on planetary and evolutionary planes as well. The primary vehicle for the implementation of ESD is the **Evolutionary Learning Community**" (From a Glossary prepared by Ken BAUSCH for ISSS, 2002)

1204

EVOLUTIONISM ^{1/3)}

The belief in evolutive **models**.

The scientific theory of **evolution** (E. SCHWARZ, 1993, p.5), ... which is quite a different matter.

SCHWARZ adds a complementary definition in order to discuss more widely the general concept: "A philosophical attitude based on evolution". He writes: "Evolutionist **theories** may have different **connotations** according to the disciplines. In natural sciences, evolutionist **models** (irreversible thermodynamics, non-linear dynamics modelization of emergence and complexification in physics; Darwinism or Lamarckian transformism in biology) have positive **connotations** in comparison to **models** without a privileged **time** direction (classical

mechanics), or fixist ones (creationism) in biology. On the contrary, in human sciences (ethnology, **sociology**, anthropology, etc...) evolutionist **theories** appeared during the colonial period, associating the **evolution** idea to **progress** (transition from the "savagery" to the "civilized" state). As a reaction other **models** appeared more recently in which the **time** problem has been sometimes abusively eliminated" (1993, p.6)

In short the evolutionist concept covers quite different **meanings**- and even intentions or prejudices- and should be carefully scrutinized wherever it appears

1205

EVOLUTIVE ACCELERATION ¹⁾

F. MEYER dedicated an important book to the global problems of evolution, with an intriguing chapter on "Evolutive acceleration" (1954, p.173).

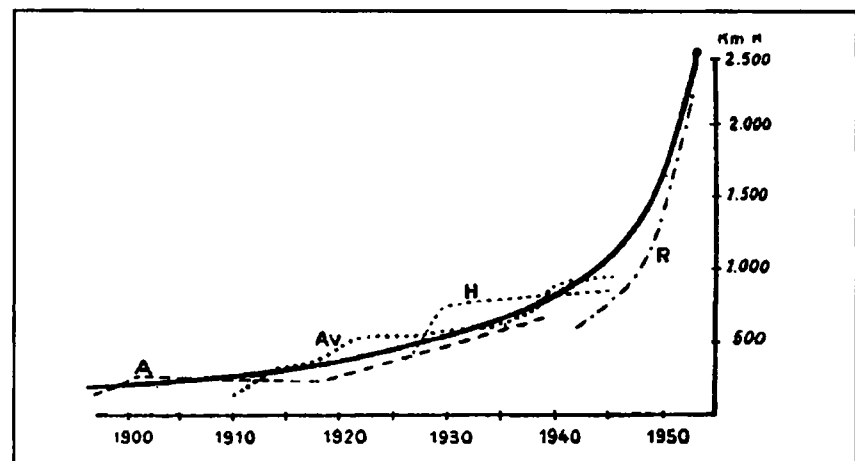
Various other authors did observe that many evolutive **phenomena** of very varied kinds seem to accelerate with **time**.

F. MEYER, in "La surchauffe de la croissance" (1974) emphasizes this **process**, at work in **growth** of the number of living species and the cephalization index of animal species; growth of human **population** planetary wide; of **population density** by square kilometer; of the length of cutting edges per kilo of stone from early paleolithic to late neolithic; of appearance of new types of tools during the same **time-span**; of urban concentration; of the quantitative use of **energy**; etc...

MEYER describes also some general and striking characters of these **phenomena**:

- Not only does acceleration take place, but altogether an acceleration of acceleration, which produces logarithmic and even in some cases hyperbolic **growth**.

Figure: see entry **EVOLUTIVE ACCELERATION**



Evolutive acceleration: Velocities

A. motor car; Av. Aircraft; H. Sea plane; R. Jet

(Note: This curve dates back 1953. Today Space rockets could be added)

From. F. MEYER: 1954, p. 71

- The mechanics of acceleration is a positive **feedback** (see figure).
- The hyper-acceleration **process** should normally be self-destructive.
- However, there is a relay **mechanism** by which, when the evolutive curve of a **phenomenon** starts to accelerate, some new **phenomenon**, more powerful, appears. As an example MEYER uses the **growth** of human displacement velocities from the old horse postal express up to the rocket. Today, he could add the interplanetary explorers.
- There is an evolution of evolution characterized by curve-embedding

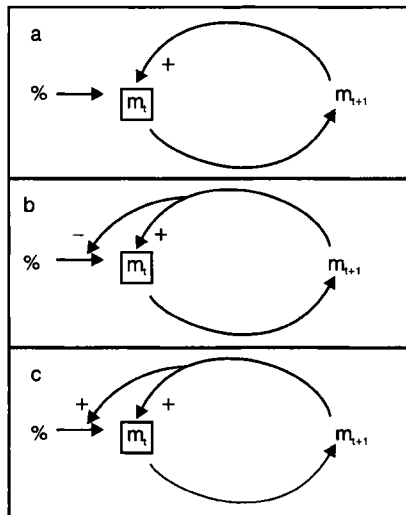
MEYER gives the following cybernetic explanation of the acceleration **phenomenon**: (1974, p. 550)

see figure next page

H. SIMON viewed the **phenomenon** from the angle of **complexification mechanism** and his argument explains the existence of the evolutive relays noticed by F. MEYER:

"Using the simplest hypotheses, the **time** needed by a great system to its spontaneous build-up starting from its "atomic" **components**, grows geometrically according to the number of its **components**. On the other hand, if a **hierarchy** exists of potential **subsets**, with more or less the same number of **components** on each **level**, then the **time** needed to constitute a system of **n elements** grows only according to $\log_n$. In other words, when big systems are built according to this **hierarchical method**, the doubling in **size** of the bigger evolving systems will be more or less constant. It may be expected that systems of size 100 evolving in an **environment** of size 50 systems will do it more or less within the same span of **time** as size 50 systems evolving in an **environment** of size 25 systems" (1990, p.134).

We will thus witness a logarithmic **growth** of the **size**, and probably the general **efficiency**

Figure: see entry **EVOLUTIVE ACCELERATION**

a. Positive feedback (m_{t+1}) of growth on the growing mass (m_t) (rate in %): exponential evolution.
 b. Same case, with negative feedback on the operator: logistic evolution.
 c. Same case, with positive feedback on the operator: self-accelerating hyper-exponential evolution.

of systems in similar lapses of time.

F. MEYER gives still another interesting insight. He hypothesizes that the general evolution process started on the morphological level and passed successively through the physiological and the behavioral one, reaching finally the technical one. This is related to the evolution of the brain: first global, next of its superior centers and finally of the cortex. (1954, p.174). In other words, evolution affected first material processes and is now acting on the information level, using energy in a quite more efficient way.

The topic has also been considered by C. BRESCH (1977) and H.von FOERSTER et al. (1960)

1206

EVOLVABILITY⁵⁾

"The capacity of genes to mutate and modify an organism's genotype without jeopardizing its fitness" (C. KOCH and G. LAURENT, 1999, p.96)

The authors write: "Evolvability should be favored by organismic compartmentation, redundancy, weak and multiple (parallel) linkages between regulatory processes and, finally, component robustness. These features all imply that evolution can only tinker with a system successfully if many of its constituents and coupling links are not essential for survival of the organism"...

Applying this to the brain, they state that it should be "... replete with specialized circuits, parallel pathways, and redundant mechanisms" (Ibid)

The evolvability concept is also probably significant for evolving complex social systems, specially the **man-planet system** presently in process of **organization**.

The author's comment is related to the evolutive path that led to the shaping of the highly organized mammalian and human **nervous system** and, particularly **brains**.

However, the concept and its shades of meaning seem to be generally applicable to any evolving system, including social **organizations**.

1207

EXAPTATION²⁾⁵⁾

Any **adaptation** that results of the posterior use of some feature arisen formerly

This neologism (I. TATTERSALL, 2001, p. 45) refers to the evolutive **emergence** of new useful **functions** in living beings which use some randomly appeared features which had no obvious utility to begin with.

He writes: "This is a useful name for characteristics that arise in one **context** before being exploited in another, or for the **process** by which such novelties are adopted in **populations**"

And "the classic example of exaptation becoming **adaptation** is birds' feathers. These **structures** are essential nowadays to bird flight, but for millions of years before flight came along, they where apparently used simply as insulators (and maybe for nothing much at all before that)" (p. 43)

Tattersall gives another example:

"...we have no idea at all about how the **brain** converts a mass of electrical and chemical **signals** into what we are individually familiar with as **consciousness** and thought **patterns**" (ibid. p. 45)

1208

EXCHANGE¹⁾

A reciprocal **flow** of **matter**, **energy**, **information** or any other commodity between two systems or **subsystems**.

Exchange is necessarily submitted to **rules** or **constraints**. It can be equal or unequal, permanent or **periodic**, steady or variable.

It supposes a convenient **communication** system.

1209

EXCITATION¹⁾²⁾

The triggering or more or less sudden increase of some **process**.

The excitation **agent** is a **stimulus**, i.e. a new or increased **input** received from the **environment** or by priming through a **positive feedback**.

Excitation is a very general **phenomenon**, that can be observed in many physical, chemical, biological, ecological, economic, psychological and social processes.

In many cases the excitation process is coupled with an **inhibition** process. their alternance allows the system to maintain itself in a restricted **range** of **stability** conditions. Excessive or too frequent excitation in some process may lead to crossing a threshold of unstability and destroy the system if not compensated in due time.

→ **Catalysis; Constraint; Far-from-equilibrium condition; Instability; Oscillators; Periodicity; Stability (Poly-)**

1210

EXCLUSION (Competitive)⁵⁾

Two species which have identical **ecological** requirements cannot long coexist in a **habitat**.

This principle was introduced by G.F. GAUSE (1936).

J.de ROSNAY proposes to replace the notion of "natural **selection**" by the one of "competitive exclusion". In his wording: "**Self catalysis** unavoidably triggers quick **growth** and acceleration; but altogether **conflicts** with the **environment**. The growing systems drain **energy** for their own use. When the **environmental resources** are limited, these systems start to compete with others. Some survive, others are eliminated.

"In this perspective **self catalysis** and **self selection** become connected. Natural **selection** cannot anymore be confused with some arbitrary **choice** made from "outside" by a supranatural entity, nor even with an **environment** endowed with some hypothetical "project". The old notion of "natural **selection**" must thus be replaced by a more general one, which integrates duration and acceleration, namely "competitive exclusion" (1975, p.230).

Various growing systems can rival to obtain scarce **resources** of **matter**, **energy** and **information** and some of them may eliminate some others. However, in a global **environment**, they all finally depend on each others. Thus a succession of imperfect and transitional **dynamic equilibria** takes place among them all. Such a **situation** is found for example in **ecology**, as well as in economy and, as noted by de ROSNAY, is in accordance with ASHBY's **Law of Requisite Variety**.

The value of the principle seems thus quite general.

1211

EXCLUSION (Mutual)⁵⁾

In a **network** of computers, "the property that the steps of one operation cannot be interleaved with steps of another" (P. DENNING, 1991, p.111).

According to P. DENNING: "One of the most fundamental requirements in all... (**networks** of computers) is that certain **operations** be indivisible: the **operations** must be carried out in some definite **order**, one at a **time**, even when different computers request them simultaneously. If, contrary to this requirement, the instructions of one **operation** were interleaved with those of another, the results would be unpredictable. Deposits and withdrawals could be lost; confirmed reservations might disappear, **parallel processing** computers could produce invalid **outputs**."

"Because indivisible **operations** are not allowed to be in progress simultaneously, we say that they are mutually exclusive" (Ibid).

It can be seen that the **simultaneity** problem is all-pervasive.

As **simultaneity** destroys perfect causal **determinism**, no perfect **algorithm** seems possible in **parallel operation**.

1212

EXCLUSION PRINCIPLE⁵⁾

If two particles occupy the same region in **quantum** space, they cannot be in the same quantum state. This means that the values assigned to the quanta numbers that characterize them must be different for different particles.

This principle was enunciated in 1925 by the Austrian-American physicist W. PAULI (1900-1958)

1213

EXERGY¹⁾

"That part of **energy** that can be used without limitations" (Diccionario RIDUERO de Ecología, translation of the "HERDER Lexicon Umwelt, 1973).

1214

EXOGENOUS¹⁾

Deriving from outside the entity or system.

Exogenous conditions or factors are considered only because they somehow impinge on the system.

1215

EXOSOMATIC INFORMATION¹⁾

The information created and eventually retrieved by **living systems** in, and from their **environment**.

This concept has been developed by S. GOONATILAKE (1992, p.83-117): "While almost all **memories** are internal in the **brain** of animals, external **memory markers** are sometimes used as cues for the internal functioning of the **brain**. Sometimes such "**memories**" are consciously created and externalized in the world outside the **brain**. Sometimes the external **memories** can be manipulated" (p.83).

The marking of territories by animals is already a form of exosomatic information. There is also a close relation with **stigmergy**. In human societies, exosomatic information became an "explosive" **process**. Men rely heavily on a growing number of non-biological external clues and devices to sustain their evermore complex **organizations**. Moreover, as noted by GOONATILAKE, exosomatic **processes** can now be manipulated and are even seemingly acquiring a kind of autonomous **activity**, through spontaneous **self-organization**, particularly in **information networks** (p.120).

1216

EXOSTRUCTURE²⁾

The **set of connections** of a system with **elements** or systems in its **environment** (Adapted from M. BUNGE, 1995, p.15).

According to BUNGE, this exostructure includes the **inputs** and **outputs** of the system and, together with its internal **structure** (which he calls **endostructure**), it constitutes the total **structure** of the system.

It seems that the exostructure is more variable and less constraining than the endostructure. For example, the internal temperature of a mammal is a much more rigorous **constraint** than the **range** of tolerable temperatures in its **environment**.

1217

EXPERIENCE (Axiom of)^{1) - 3)}

"The future will be like the past, because, in the past, the future was like the past".

This ironical so-called "axiom" by G. WEINBERG is a "wolf in sheep clothes". Our **knowledge** of the past is always quite relative and we now understand why this is so: **Deterministic chaos** in complex **situations** makes practically impossible not only a perfect prediction of future but altogether a complete **understanding** of the tangle of **causes** that produced some past **event**.

We thus can never be sure that a present **situation** apparently similar to a former one will evolve in exactly the same way.

1218

EXPERIENCE (Law of)¹⁾

"**Information** put in by **change** at a **parameter** tends to destroy and replace **information** about the system's **initial state**" (W.R. ASHBY, 1958, p.139).

This law seems somewhat contradictory with the basic concepts of **autopoiesis** and **organizational closure**, which correspond to dynamically stable systems.

On the contrary, it seems to fit better with **chaos** concepts and possibly finds an illustration in **FEIGENBAUM's number**.

1219

EXPERIENCE LOOPING^{1) - 2)}

The use of permanent **feedback** between producers (inventors, researchers, engineers, managers, etc...) and users (servicing technicians, clients).

This **cybernetic methodology**, proposed by M. MARUYAMA (1985, p.385-89) aims at successful product invention, development and **adaptation**.

It allows for better **information** about the variable and specific conditions of a technique's use in different physical and human **situations**.

It includes **design** looping, in which "the **components** are re-designed for the final product, and, **concept** crossing which "is the combination of concepts from different fields of specialization (in which **process**)... much foresight is needed on the part of the **management**" (p.387).

MARUYAMA gives some impressive examples in his paper.

1220

EXPERIENTIAL FIELD^{1) - 3)}

The total extension of all what an **observer** is able to register after having received a specific training.

As stated by E.von GLASERSFELD the **observer** extends his/her experiential field "... using the **invariances**, **rules**, and **concepts** he/she has constructed for him/herself in the course of his/her past experience" (1976, p.118).

1221

EXPERIENTIAL STATE²⁾³⁾

A fleeting state of the **brain** that results of the interaction of "sensory **perceptions**, **memories** and emotions"(after F. CAPRA, 1997, p. 292)

Capra thus reproduces MATURANA and VAR-ELA's concepts about the way we connect with the "real"world. Such experiential states produce a "unitary mental space", but "the experience is not constant...and may be extremely short"(Ibid)

Capra explains "...transitory experiential states are created by a **resonance phenomenon** known as "**phase locking**" in which different brain regions are interconnected in such a way that all their **neurons** fire in **synchrony**. Through this synchronization of neural activity, temporary "**cell** assemblies are formed, which may consist of widely dispersed **neural circuits**"(p. 292)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1222

EXPERIMENTAL FRAME²⁾

"A set of **variables**, their **state set** with appropriate **observation channels**, **time** (as a **parameter** within which the **variables** are observed), and an appropriately defined **time set**" (G. KLIR, p.151, 1988).

Obviously, the experimental frame *determines* what we are going to register, at which **level** and in function of which implicit or explicit **methodology of inquiry**.

As to the **time set** for example, it is not indifferent whether the observations are made every second, twice a day or once a year.

→ **Reconstructability analysis**

1223

EXPERIMENTAL NEUTRALITY¹⁾

Such a kind of neutrality is advocated by P. CHECKLAND and his followers. The neutral researcher is supposed to enter the field without preconceived theories or **models**, i.e. with a to-tally open mind.

While this is obviously an excellent proposal, it is however quite difficult to practice. Our more deeply engrained preconceptions (or prejudices) are precisely the most difficult for ourselves to become conscious of (de ZEEUW's "**invisibility**") and to take care of in our **interaction** with the problem we tackle. There exists thus no such thing as a neutral **observer-actor** and a healthy beginning should probably include a kind of "declaration of personal prejudices" ... if we become ever capable to do that.

1224

EXPERIMENTALISM^{1) - 3)}

A **methodology** of inquiry that assumes the indissoluble interconnection between **facts** and scientific laws.

Experimentalism has been proposed by E.A. SINGER Jr. and developed by C.W. CHURCHMAN and R.L. ACKOFF.

In their overview of experimentalism, G.A. BRITTON and H. McCALLION write: "All **knowledge** of law implies **knowledge** of **fact**, all **knowledge** of **fact** implies **knowledge** of law. For experimentalists there are no fundamental **truths**. Some laws have to be assumed in order to learn, but in addition, some **facts** have to be known in order to generate laws. **Facts** and laws are inextricably intertwined, they cannot be separated. **Truth** is not the starting point of **inquiry**; it is the end point" (1994, p.490).

This is coincident with the **autopoietic** view of the **observer**: **perceptions** as well as **concepts** are closely linked within the **observer's organizational closure**.

According to C.W. CHURCHMAN, the "original question becomes more and more complicated, *not* simpler and simpler. This **learning** "more and more" is what, following SINGER, I call the "sweep-in process" of **systems science**" (1981, p.1-2).

Some important results of this approach are:

- 1) no science is more fundamental or important than another;
- 2) experimentalism moves the attention away from what scientists *actually do* to what *they ought to do* and
- 3) experimentalism assumes a **teleological** view of the world (1994, p.491).

Experimentalism breeds a method of insight and intuition and, in the case of CHURCHMAN, an **ethical** view of science: The **meaning** of reality is an ideal to be pursued.

1225

EXPERIMENTATION SPACE³⁾

A mental and physical space "... created in order to allow for **design** experimentation and the testing of emerging **design** alternatives as well as the **assessment** of the on-going **design** itself" (B. BANATHY, 1988, p.33).

This is an important feature of BANATHY's concept of **design**, because it results in **design** not being a closed-off or unduly restricted **domain**.

1226

EXPERT SYSTEM⁵⁾

A computer **program** able to resolve some problems in a way comparable to an expert or a group of experts.

An expert system includes a **data** bank and **rules** to use them. The **rules** are constructed by "**knowledge engineers**" who extract the **knowledge** considered relevant from conversations with human experts and transform them into "production **rules**" usable in a computer to compare and interconnect **data** in significant ways, in order to produce useful conclusions. This is obtained through an "inference engine" which establishes coordinated general ways to apply the production **rules** to **data** corresponding to any specific case. This leads to the shaping of a **decision tree**.

The classical expert systems are thus typically **algorithmic**, but they ultimately depend from human expertise. Nevertheless, the more advanced **connection machines** permit the use of inductive **programs**, using "... a purely logical approach to *find* abstractly defined regularities in the **data**, irrespective of subject-matter" (M. BODEN, 1991, p.186).

Thus: "A **learning program** that uses this logical strategy can structure a *classification-by-property conceptual space* in the most economical way, and can find the shortest pathway for locating examples within it" (Ibid).

The **rules** collected in an expert system may also represent the **consensus** making **process** between different objectives (See ELF Supplement - New Scientist Vol 138 - n° 1870 - 04.24.93, p.7).

ELF Company applied the following features in its GRANDPUITS refinery in France, for refinery **automation**.

The proposal was to ensure the quality of production, as well as the long life of the unit, but also taking in account the action required to run the plant on a day-to-day schedule. This included:

"... on the spot analysis of the **behavior** of each **part** of the unit;

" **decision-making**, in order to create a **control strategy** taking into account the **time** factor of the **actions**;

" more detailed **control** procedure with the **commands** routed to the **controllers** throughout the **network**.

"This required that the system be fully integrated in the **real-time environment**" (Ibid).

Expert systems are designed within the technical perspective and so, are weak or useless for the organizational or societal perspective, and still more so for the personal perspective (I.I. MITROFF and H.A. LINSTONE, 1993, p.105).

1227

EXPLANATION³⁾

"Any theory that logically implies,... reconstructs or generates what has in fact been observed" (K. KRIPPENDORFF, 1986, p.30).

M. BUNGE (as quoted by J. CASTI, 1990, p.38-40) distinguishes causal and noncausal explanation and typifies them as follows:

Causal explanations

- a) Inclusion in a sequence
- b) Tracing origins and **evolution**
- c) Connection with other **facts**
- d) Analysis

Noncausal explanations

- e) Membership in a **class**
- f) **Description**
- g) Static **structure**
- h) Reference to a lower **level**
- i) Reference to a higher **level**
- j) Statistic
- k) **Teleology**
- l) Dialectic

CASTI comments: "Causal explanation will be found only within the laws of science and nature, not outside them. In short, scientific explanation is explanation by law, not by **causes**" (p.40).

Explanation (Systemic)

More specifically, systemic explanation rests on a **systemic epistemology**, based on general principles related to observational conditions and conceptual construction. It also uses general **isomorphic models** that can be applied to describe a great number of similar **processes** and **structures**.

Systemic explanation does not suppresses nor supplants traditional rational and scientific explanation, as it is directed to a different type of **objects**. It merely creates a wider **frame** within which they become included and can still be used when specifically efficient.

However, to round up in a more skeptical and general mood, BATESON believed that any explanation simply connects two statements in a **semantic** way. This is the case for any explanation, but it leaves always open the possibility that one must in the end accept or reject such semantic arrangements as bona fide "explanation" (within brackets!)

→ **Purpose**

1228

EXPLOSIVE PROCESS^{1) - 2)}

A self-destructive process resulting from a constantly recurrent **positive feedback**.

Any process must be fed by some kind of **inputs**, whether material, energetic or informative, obtained from an **environmental source**. As **positive feedbacks** produce a major need of **inputs**, the accumulative acceleration of their use tends to an also accelerated exploitation of the **source**, leading to over-exploitation or **overburdening**. This in turn leads the process to a **runaway event** that leaves it (and the system it belongs to) more or less quickly without the needed **inputs** (or **outputs outlets**, or **sinks**) and ends up in its destruction.

The same **phenomenon** may also lead to internal **overload**, or in **populations**, to **overcrowding**. Paradoxically, such **overload** is conducive to a kind of de-synchronization and lysis of the normal **interactions network** and to the uncoordinated dispersal of the members of the **population**. (B. WALLISER, 1977, p.84).

1229

EXPLOSIVE-IMPLOSIVE PROCESS^{1) - 2)}

A process of expansion that reaches a **limit** and is replaced by a process of contraction.

This is a result from an over-exploitation and exhaustion by the system of the **source of inputs**.

It is different from the explosive-destructive process although it may also finally destroy the system. It is also different from **logistic growth**, where a **damping** or braking **feedback** leads the system to a **situation of asymptotic or dynamic stability**.

R. VALLÉE describes a mathematical formalism for the explosive-implosive process (1995, p.63-5).

1230

EXTERNALITIES¹⁾

The **set** of factors that do not seem to influence significantly a system or some of its **processes**.

This is a very deceitful concept, specially in economics, because externalities are defined according to a set of generally uncriticized principles or **rules**. Moreover, as systems become wider embracing, more and more externalities should be taken in account as significantly related to them.

There is also a **long-term trend** aspect. Some factors, for instance the slowly accumulative ones, do not manifest their impact for decades or centuries and thus are classified as externalities... unless suddenly they introduce unexpected **disturbances** (or offer new opportunities).

According to K. KRIPPENDORFF: "Externalities may also be regarded as the nonanticipated **side effects** of calculated courses of **action**" (1986, p.30).

It could be better to speak of *ill-calculated* courses of **action**, generally because of a non-systemic partialized view of the **situation**.

1231

EXTERNALIZATION¹⁾

The shift from strict biological **control** in **living systems** to a measure of psychic and social **control**.

S. GOONATILAKE speaks of **exosomatic information**, based on cultural **interrelations**. According to him: "Animals interact with the **environment** using a wide **variety of input and output channels** such as chemicals (f.ex. pheromones), acoustical and electro-magnetic waves and mechanical intervention with the **environment** using limbs and such devices as tools" (1991, p.83).

This amounts to be able to "reading" clues in the **environment**, as in **stigmergy**, or through **positional values**.

What GOONATILAKE describes as the exosomatic sphere, in the case of humankind, is presently in a **process of evolutive acceleration**, through the exponentially growing number of **artefacts** created by technological man. However these **artefacts** also increasingly *control* human societies.

1232

EXTINCTION¹⁾

The complete and definitive disappearance of a **class** of systems.

Extinction, as a general concept, express that some **class** of living beings or **organizations** has become unfit in a transformed **environment**, because it could not evolve to readapt to changed conditions.

It is a systemic concept, since it can be applied to dinosaurs, archaic cultures, feudal principalities, or stagecoaches, or even possibly **living systems** in planets becoming unfit for life. Extinction is heralded by the progressive

reduction of the number of members of the **class** and/or by **critical changes** in the physical, ecological, technical, economic or socio-political **environment**.

1233

EXTRAPOLATION¹⁾

The inference of **forecasts** or unknown **information** from historical **trends**.

Extrapolation is, from the systemic viewpoint, one of the most risky method at hand. It supposes the unperturbed continuity of existing **trends**, and even the correctness of the **evaluation** made of the latter.

It implies the beliefs: 1) that the **relationships** between relevant **variables** will remain **stable** (i.e. that the system is basically **linear**); 2) that long or extra-long **trends** are effectively known (f. ex. the multi-secular **oscillations** in climate); 3) that no ignored or new factor could influence the system (f. ex. the appearance of sporadic and ulterior **runaway** resistance of insects to insecticides).

Catastrophe theory, as well as **chaos theory** and **dissipative structuration** show that extrapolation has very narrow limits as a predictive technique.

1234

EXTRAREGULATOR¹⁾

A system which is able to adapt to a point its **environment** to its internal needs for **constancy**.

This concept was introduced by G. BATESON as complementary to those of "**adjustors**" and "**regulators**". He wrote: "... the polarity between **adjustors** and **regulators** can be extrapolated another step to include what we may call 'extraregulators' which achieve **homeostatic controls** *outside* the body by changing and controlling the **environment** - man being the most conspicuous example of this class" (1973, p.332).

Social insects (as well as a social mammal, the naked mole rat) also achieve extraregulation, at least up to a point, by creating their own artificial **environment**.

E. JANTSCH observes that this "...centrifugal evolution is favored by **variable stress** and thus incorporates a basic principle of **nonequilibrium** and **fluctuation**, whereas constant **stress** would favor a centripetal direction of **evolution**" (1976, p.55).

1235

EXTREME VALUE THEORY²⁾

A **forecasting set of models** that can be used to predict the likelihood of extremely rare **events**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The theory is based on **distribution** curves (Gumbel, Fréchet and Weibull curves) which give "a precise quantitative statement of the otherwise vague notion that the more extreme the event, the less likely it is to happen" (R. MATTHEWS, 1996, p. 37-38).

The theory has been developed by R. SMITH (Univ. of North Carolina) and L.DE HAAN (Erasmus University, Rotterdam).

It offers no real possibility of precise **predictions** but is useful for determining the most extreme possible events in accordance with statistics of lesser similar events in the past, on a long **time scale**.

Dutch experts have found for example that the maximum known historical flood due to a North Sea storm in Holland has topped 4 meters above sea **level** (in 1570). It has thus been estimated that walls of 5 meters upon the sea level should meet a criterion of a once in 10 000 years flood. (see GOLDENFELD and KADANOFF, 1999, p. 87)

Other examples are volcanic eruptions, big earthquakes, crashes in stock markets, **epidemics in populations**, hurricanes in the Caribbean zone, the "El Niño" **events** in the Pacific Ocean. **Intermittence** generally implies sudden paroxysmic **changes** or an epochal **reversal** in-between variable but long **relaxation periods**. It is related to **synergetic processes**, **power laws**, and **dissipative structuration**, all of these probably governed by great **fluctuations of energy inputs**, or their cumulative **long term effects** (ibid, p.87-89).

→ **Numbers (Prime); Periodicity; Term (short-, medium-, long-)**

1236

EXTRUDER ^{1) - 2)}

"The **subsystem** which transmits **matter-energy** out of the system in the form of products or **wastes**" (J.G. MILLER, 1978, p.3).

The extruder is one of the **20 critical subsystems** in MILLER's **taxonomy of living systems**.

F

1237

FACILITATION ^{4) - 5)}

The use – by a facilitator – of a array of material, computer and/or intellectual and behavioral techniques in order to help a **group** to overcome difficulties in grasping complex **situations** and designing.

Facilitation is a practical necessity in any **group** concerned with the **evaluation** of complex **issues** and **situations**, **design** and **management**.

However, the facilitator needs a specific training in **Group technique**, **Interactive Management** or **Co-participative Design**. He/she should not, as facilitator, interfere with the **group's activity**, and still less acting as an overpowering "leader".

1238

FACTOR (Co-) ¹⁾

A secondary **cause** or circumstance that contributes to the permanence or **change** of some **process** or **situation**.

Co-factors should be monitored because they can nudge the **process** or system toward a critical **threshold**, while they are frequently ignored, overlooked or underrated.

1239

FACTORIALITY ¹⁾²⁾

Factorial multiplication of combinations between **elements** is obtained through the product of all positive integers from 1 to n, n. being the number of elements intervening in the combinatory.

This is represented by n!, as a short hand for 1.2.3...n.

Obviously, the number of possible combinations among elements grows in an accelerated way in accordance to the number of elements in the combinatory.

This is however an abstract **model**; it is implicitly admitted that there are no restriction of any kind for some combinations.

In practical situations such restrictions appear promptly because for ex. of **environmental** limitations that block or brake the multiplication of the elements, or through **saturation** of their relational **network**.

→ **Combinatorics**

1240

FACTS as CONSTRUCTS ³⁾

K. KRIPPENDORFF defines a fact as "Anything described and held to be true". He also contrasts facts with statements that may be "untrue, surmised" or hypothetical, or reflect fantasies or beliefs (1986, p.30).

Coincidentally G. BATESON states: "There are, in a sense, no facts in nature; or, if you like, there are an infinite number of potential facts in nature, out of which the judgment selects a few which become truly facts by that act of **selection**" (1973, p.456).

St. BEER puts in the following words: "Science is supposed to amass "the facts" and then to form hypotheses based on those facts. But the hypothesis is already covertly implicit in the **selection** of the facts, and further selection of a less than overt nature occurs during the **process** of elaborating the hypothesis further.

The continuing **operation** is **circular**. That is why cybernetics takes *ouroboros*, the snake that bites its own tail, as a suitable logo, and talks about **circular causality**" (1999, p. 441)

It could be said that a fact is something that can be observed, perceived and understood within a conceptual **frame of reference**, which serves mainly to define facts in function of **contexts** (which can be shifting in **time**, as shown for example by astronomical "facts" from Ptolemaic to Einsteinian viewpoint, through Keplerian and Newtonian ones). T. SANDOZ writes: "A fact becomes observable at the moment that it becomes interpretable"... and interpretations can be variable: an earthquake is a disaster for the affected people, but for the geologist, it is a manifestation of plate tectonics. Moreover, "A fact is nothing without a theory" (1993, p.1544)... i.e. any "fact" contains an implicit theory. That would be true also for archaic myths, considered as explanations based on a **class** of proto-theories.

Now, how do we select our facts?

What we call "facts" are merely **constructs** of our **brains** elaborated from our **perceptions** of "things" or **events** "there outside" and their **processing** by our neural **networks**. Moreover, anyone selects his/her facts according to the personal **organization** of his/her cerebral **networks**, as it resulted from training and **learning**.

As argued by P. DENNING: "Science is a **process** of constructing facts" (1990, p.102). It is not the only one, but it is the most reliable, because it is solidly based on non-contradictory **coherence** and possible refutation (POPPER).

Facts are thus merely "facts": They are basically a possibly provisional **consensus** on some **representation** of "something out there" and should not be given an absolute and definitive value. In the words of the French physicist B. d'ESPAGNAT "reality is veiled" (1979). This caveat is a much needed self-protection against many delusions.

1241

FAILURE TREE ²⁾

An analytical **graph** which seeks in a deductive way to determine the basic elementary **cause** of a failure in some device.

The tree is constructed by sequential elimination of the sections of the **process** which are not responsible for the failure.

Of course, the correct initial **selection** of the failure in precise terms is a requisite condition for the construction of a useful tree.

The enquiry use the logical door "or" at every discriminating **distinction** in the **process** of construction of the tree.

The **analysis** should be ended when the cause of the failure is identified at the operative **level** at which an intervention is practical and sufficient.

→ **LUSSER theorem**

1242

FALSE PEAK→ **Optimum (Local)**

1243

FALSIFIABILITY³⁾

"Capacity of a theory to generate a test which, if failed, refutes the theory" (R. FIVAZ, 1991, p.32).

This epistemological concept – also known as "refutability" – has been introduced by K. POPPER.

D. BOHM and F.D. PEAT explain: "Repeated experiments, made on the basis of a theory's predictions, will certainly increase its credibility among the scientific **community**, but they can never *prove* its correctness in any absolute sense. All theories are in some way limited, and while a series of experiments may confirm the theory in some limited **domain**, they cannot rule out the possibilities of exceptions and novel **behavior**. The best that science can do, therefore, is to falsify a theory by establishing some significant point of **deviation** between experiment and prediction" (1987, p.58).

R. FIVAZ observes however: "General theories such as **thermodynamics**, often do not specify completely how they are to be applied; therefore, they are immune to test by reality and consequently unfalsifiable" (Ibid).

This is also the case of so-called **General Systems Theory**... insofar as it may really be considered a "theory".

This is an intriguing point. In fact, it would seem that the falsifiability **criterion** can be applied in a strong sense only to classical and narrowly specific **deterministic** theories. In M. BUNGE's words: "Evidently, the more general a theory, the wider the **domain** of **facts** it refers to, and the less testable it is" (1993, p.221).

True or false is in such a case a too narrow **dichotomy** and testability *in these terms* an off the mark **criterion**.

Could *models* (as for example **catastrophe** or **chaos** ones) be either proved or disproved?

From a strict **semantic** viewpoint, the very term "falsifiability" seems unfortunate, as, for superficial minds, it seems to introduce the notion of falseness. However, neither the corpuscular, nor the ondulatory theory of light have been recognized as "false": they merely became integrated within a more general embracing theory.

For a short and very readable synthesis about "thinking about thinking" and an **evaluation** of POPPER's falsifiability, see M. CROSS (2000)

1244

FALSIFICATION (Cross)³⁾

A practical way to falsify (in POPPER's sense) theories about the workings of natural systems.

Such a **method** is proposed by M. CHRISTIE (2001) because complex natural systems cannot be subjected to experimental **control**. Even **computer simulation** may be inconclusive because it depends on the characters of the **model**, as derived from the set of hypothesis. Moreover the **computer model** may in part result of **choices** dictated by computational logical (**binary**) necessities.

CHRISTIE states that only cross-falsification is useful, i.e. by creating an interplay between two antithetic theories (for ex. that chlorinated components produce the ozone hole, or that they don't).

If they demonstrably do not, some other explanation should be found and different **forecasts** about the respective **effects** could be proposed. The observed **deviations** from the respective **predictions** should reveal the real superiority of one theory over another.

1245

FAMILY THERAPY⁵⁾

A current in psychology and psychiatry based on systemic concepts, mainly centered on **autopoiesis**.

Familiar therapists rejects the "**Olympian stance**", common in their trade, which induces most psychologists and psychiatrists to believe that they can treat their patients only on the bases of **objective observation**; generic concepts about some **classes** of mental illnesses and some **objective guiding** of the patients.

Familiar therapists try to better understand what "being an **observer**" implies and, as a result, they consider that their **interactions** with the patients are not neutral. Moreover, they believe that no patient can be isolated from her/his personal **environment**, and, more specifically from her/his family, which generally presents psychological **closure**.

The therapist interventions aim at a better **integration** of the whole family **group**, including a better **adaptation** of its members **behavior**.

1246

FAMINE→ **Net (Access problem in a net)**

1247

FANNING²⁾

A synonym for "**branching**"

1248

FAR-FROM-EQUILIBRIUM CONDITION^{2) - 5)}

The condition of a system undergoing widening **fluctuations** that leads it close to an **instability threshold**.

I. PRIGOGINE describes it as follows: "Here the **fluctuations** may be amplified and change the **macroscopic pattern** of the system. The **state** of the system extrapolated from the **equilibrium state** becomes unstable and, through **fluctuations**, is driven into a new **state**. **Instability** means that under these conditions existing **structure** cannot be maintained: the system has now become open to... a multiplicity of new possibilities and the phenomenological equations... cannot predict which of the new possibilities will be realized. **Evolution** of the nonequilibrium **structure** depends on some singular **factor** that happens to occur at the right time, at the right place: it depends on **chance**" (1984, p.48).

1249

FATAL EMBRACE→ **Net (Access problem in a)**

1250

FEASIBILITY (Cultural)⁴⁾

The effective possibility (or impossibility) to implement some economic, social or political **change** in a specific cultural setting.

Many projects, under others so-called **development** projects, are elaborated by members of one **culture** for implementation in another culture. In numerous cases, this kind of planning is done without any serious research and understanding of the cultural (or even **environmental**) conditions of the recipient human **groups**. This includes for ex. **values** and **norms**, **beliefs**, traditional ways, etc..., including the deep reasons which explain and, in many cases, justify the former.

Frequently, the results are dreary.

This is a typical systemic problem whose root is the ignorance of deep differences between the mental **frames** of the proposers and the real **stakeholders**.

The main responsibility belongs however to the proposers, who are frequently themselves unaware of the limits of their own **mental frames** of **interpretation**

Such **situation** is a very general recipe for disaster, sometimes even in the long run for the counsellors themselves.

R. RODRIGUEZ ULLOA, who introduces this concept (1994) explains: "This implies that it is the culture of a specific society, as a **whole**, that must be able to accept, as significant and possible, some sequence of **changes** (p. 139)

It becomes indeed ever clearer that many societies reject plans of change, mainly introduced by international **organizations** because they are unable to understand them or to accept the **disruptions** that the projects provoke in their way of living or **Weltanschauung**

→ **CATWOE;Rejection reaction;Soft Systems Methodology**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1251

FEEDBACK¹⁾ – 2)

1) "A unilateral power **amplifier**, with a fraction of the **output** of the **amplifier** subtracted from or added to the **input** of the **amplifier**" (M.D. RUBIN, 1968, p.9).

2) "The use of part of the **output** of a regulated system to compare with the **standard set** for its **program** and produce appropriate **change of input**" (J.Z. YOUNG, 1978, p.292).

The first definition is an engineer's one corresponding to a host of practical devices. It can be generalized by substituting "**effect**" for "**power**".

From this definition it is already obvious that any feedback device will have either positive (increasing) or negative (decreasing) **effects** on the **process**.

J.Z. YOUNG's definition explains what feedbacks do.

He adds that: "**Positive feedback** increases the **input** and negative feedback decreases the **input**", something whose disequilibrating consequences on the system are portentous when sustained feedback of one or the other kind are not adequately compensated.

The Italian epistemologist V. TONINI states: "Feedback is the dominant condition for **self-regulation**, **adaptation** and **automation**; this is sufficient within the limits of a well defined **control** of some **variable**. Feedback is a typically **analogic** and conservative principle. (However) nowadays this certainly very important principle seems insufficient for the **cybernetic regulation** of complex **organisms**" (1971, p.288-9).

What is needed in such cases is a compensating and appropriate alternance of positive and negative feedback, in order to secure **homeostasis**.

The following definition, by G. PASK is more typically cybernetic and, thus, general: "Return of a **signal**, indicating the result of an **action**., in order to determine further **action**" (1961, p.114).

R.L. ACKOFF and F.E. EMERY introduce an **information** as well as psychological connotation in their own definition: "**Information** received by the sender of a **message** about the receipt of, or **response** to his **message**" (1972, p.187).

R. VALLÉE points out that H. SCHMIDT (1894-1968) had already introduced during the thirties an *Allgemeine Regelkreislehre*, i.e. a "General feedback loops science" (1995, p.13), being thus another forgotten precursor of cybernetics.

1252

FEEDBACK and DIRECTIVE CORRELATION²⁾

Feedback, as an elemental behavioral **mechanism**, has been modeled by **cybernetics**.

Repetitive **positive feedback** tends to lead to the system's destruction by **explosion**. Repetitive non-compensated **negative feedback** also tends to its destruction, in this case by progressive immobilization. A good **regulation** needs the alternance of both types, which implies the existence of a **directive correlation**. This last is more than a simple **error control device** in a single **function**, because it must take in account the **transformations** in other **functions**.

1253

FEEDBACK (Anticipatory)¹⁾ – 2)

A feedback "governed by... **response** to the antecedents of **environmental states** that would influence the system unfavorably (or favorably), rather than by **response** to the **state** as actually present" (K. SAYRE, 1976, p.58).

This kind of feedback can work only if paired with a **repertory** of **sequences of events** that have influenced the system formerly. This enables it "... to detect precursors of disruptive **environmental events** before the latter occur and to employ its **effectors** in avoidance procedures" (Ibid). As a result "... corrective **response** precedes **environmental disturbances**" (p.221).

Anyhow, as in any feedback, a **time-lag** is unavoidable.

Moreover, unprecedented **environmental events**, or those whose occurrence remains unpredictable cannot be compensated by anticipatory feedbacks.

Anticipatory feedback of a more complex nature seem to emerge as systems themselves become more complex.

1254

FEEDBACK (Heterotelic)²⁾

"A feedback that works to maintain the **organism** in a certain **relationship** with its operating **environment**, rather than to sustain a certain internal **state**" (K. SAYRE, 1976, p.54).

SAYRE adds: "Heterotelic feedback differs from **homeostasis** in directing the **response** of the environmentally stimulated system back to the **environment** rather than containing it within the system itself" (Ibid).

1255

FEEDBACK (Positive)¹⁾ – 2)

A feedback that accelerates or increases some **process**.

Positive feedback unavoidably is a disequilibrating **phenomenon**.

It implies an accelerated pumping of some specific **resources** from the **environment** by the system, generally feeding a **runaway growth** which finally escapes from any possible **control**.

Such a **situation** leads normally and swiftly towards the exhaust of the critical **resource** and, consequently to the **collapse**, or even destruction of the system.

One may give as examples: a nuclear or chemical explosion; the inordinate **growth** of a **population**; a **runaway** bull or bear market (mind the 1929 and 1987 crashes); a fire; a cancer.

Fortunately, but possibly somewhat optimistically in some cases, in J.H. MILSUM's words: "Upper and lower **constraints** always exist in real systems which prevent true **runaway**" (1968, p.39). A good **knowledge** of these **constraints**, – in many cases located in the **meta-system** – and their proper use, is very useful in maintaining the **stability** of a system. On the contrary, unawareness of their existence may lead to their unwitting removal, **triggering** the **runaway process**.

For practical purposes, feedbacks, natural or introduced, specially positive ones, should always be closely monitored, in order to avoid unforeseen and unwanted quantitative **effects**, leading ultimately to qualitative ones.

Positive feedbacks can be controlled, but only a priori, by well conceived **design**, not a posteriori.

1256

FEEDBACK (Positive and Negative)¹⁾ – 2)

There is some redundancy in feedback terminology.

According to J.H. MILSUM "... the following approximate equivalence exist between ... various expressions (in use):

"Positive feedback, or Positively- connected loop equals: **Deviation-amplifying Mutual Causal Loop** (MARUYAMA), Disequilibrating Feedback (BOULDING).

"Negative feedback or Negatively-connected loop equals: Deviation-counteracting (or Attenuating) Mutual Causal Loop (MARUYAMA); Equilibrating Feedback (BOULDING)" (1968, p.23).

J.de ROSNAY describes the different types of feedbacks in this way:

"In any feedback (as its name shows), **informations** about the results of some **transformation** or **action** are sent back at the entry of the system, as **data**. If these new **data** tend to make easier or accelerate the **transformation** in the same direction as the former results, we have a positive feedback: its **effects** are cumulative. On the contrary, if these new **data** acts in the direction opposite to the former results, we have a negative feedback: its effects stabilize the system. In the first case, there is an exponential **growth** or decrease; in the second one, **equilibrium** is maintained.

see figure next page

Positive feedback..... Negative feedback
Divergences increase There is **convergence**
 towards a **goal**

J.de ROSNAY insists on the destructive effects of positive feedbacks:

"A positive feedback leads to a divergent behavior: illimited expansion, explosion (**runaway** to infinity) or complete block up of **activities** (**runaway** towards zero), as "more" engenders "more", with a "snowball effect". There are numerous examples: chain reaction, demographic **growth**, **growth** of a business, capital with compound interests, inflation, cancerous cells proliferation.

"On the contrary when "less" engenders "less", everything is shrinking. Some typical examples are default of a business or economic depression" (As shown by J.M. KEYNES).

"In either case a positive feedback left free can only lead to destruction of the system, be it by **explosion**, be it by blockage of all its **functions**. The exuberance of positive feedback – this potential death – must be controlled by negative feedbacks.

"This is the essential condition if a system is to maintain itself through **time**.

"A negative feedback leads to an adaptive or finalized **behavior**, i.e. **converging** towards an **objective**: maintaining a **level**, a temperature, a concentration, a velocity, a course.

"In some cases, the **goal** became established by itself and has been maintained all along **evolution**: the system "secreted" its own finality (a steady composition of atmosphere or oceans in the **ecosystem**; of the **level** of glucose in blood, etc.). In other cases it has been set by man into **machines**: **automata** and **servomechanisms**.

"In a negative feedback, any positive variation evokes a negative one (and conversely). There is a **regulation**: the system oscillates around an **equilibrium** position which it may never reach: a thermostat or a water tank equipped with a float are very simple examples of **regulation** by negative feedback" (1975, p.102-3).

The notions of positive or negative feedbacks carry some quite widespread **ambiguities**:

1- Those not familiar with the question tend to associate "positive" with "good" and "favorable" and negative with the contrary. While it is not exactly the opposite way, it is correct that positive feedbacks are generally destructive when repeated, while negative feedbacks (as understood by de ROSNAY) (see below) have regulating and equilibrating **effects**.

2- Some understand as "negative feedback", the "less" brings about "the less" described by de ROSNAY, as one of two opposite kinds of positive feedback. In this case, the negative feedback of de ROSNAY could be described as "compensated feedback" or "**regulator**": an alternance of accelerating and braking effects. There is no rigid **convergence** towards some **goal**, but the maintenance of **dynamic stability** (or **homeostasis**) within a maximal and a minimal **value**.

back through which the system adapts itself, according to the existing regulating **mechanisms** that it already possesses, which become activated, as they are.

However, the system may need to modify the **regulators** themselves in order to better their **action**, as needed when its **responses**, based on the **regulators**, as they are, become unsatisfactory. This **process** is basic for **learning**.

W.R. ASHBY explains it in the following way:

"The basic **rule** is equivalent to the following formulation:

"1 – When the essential **variables** (of the system S) are not all within their normal **limits** (i.e. when the trial has failed), no **state** of S is to be equilibrated, for the **rule** is that S must go to some other **state**.

"2 – When the essential **variables** are all within normal **limits** then every **state** of S is to be equilibrated" (1960, p.84). (ASHBY's first point is interestingly close to H. SELYE's concept of "**General Adaptation Syndrome**", but is obviously more general).

ASHBY pursues: "... any system that has essential **variables** with given **limits**, and that adapts by the **process** of testing various **behaviors** by how each affects ultimately the essential **variables**, must have a second feedback formally identical (**isomorphic**) with that described. This deduction holds equally for **brains**, living or mechanical" (p.85).

1257

FEEDBACK (Second order or double)^{1) - 2)}

A feedback which modifies any primary feedback, thus changing the former **response** of a **regulator** to some **class** of **inputs**.

When a system's **parameter** undergoes a variation, the first **reaction** of the system is processing the **information** it receives about the **change**. This generally leads to a first feed-

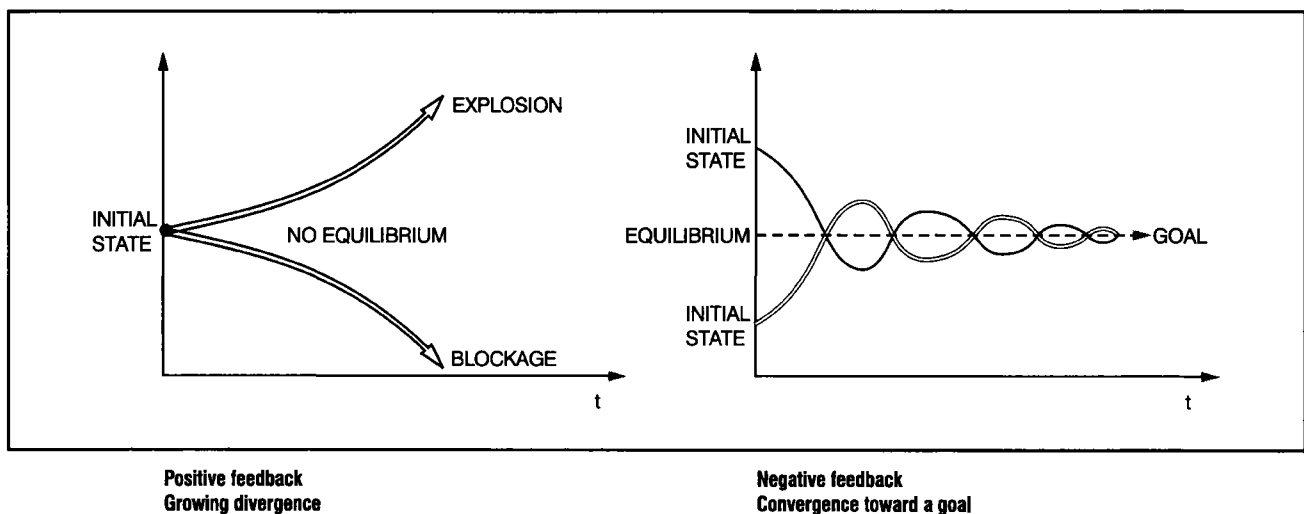
1258

FEEDBACK (Self-normative)¹⁾

A **learning process** by which the trainee corrects and restricts its or his/her **repertory** of **actions** by **perception** of its or his/her own **performance**.

A bird who is learning to sing "must be able to hear itself during the motor development **phase** (**period** during which it produces a "pre-song"). If it is deprived of hearing before the

Figure: see entry **FEEDBACK (Positive and Negative)**



From J. de ROSNAY: 1975, p. 102

beginning of the "pre-song", it cannot harmonize its vocal production with what it recorded of its species one. It can then produce only a variable song, unstructured and devoid of all the characteristics proper of its species" (J.W. CLARK, 1972, p.468).

This seems to be a very general feature of **learning**, as shown for example by the inability of the "wolf-children" to learn correctly a human **language** when isolated from humans for too long a **period**. It seems also to be related to the concept of **constraint** (ASHBY): any **learning** is at least in some respects a constraining **algorithmization** of potentially much more extended capabilities.

1259

FEEDBACK (Unforeseen)^{1) - 4)}

In many **complex systems** – particularly natural systems manipulated by man – unforeseen feedbacks appear after some **time**.

Most human interventions in natural systems take place without a satisfactory **understanding** of the intricacies of the same. There is an implicit belief that some supposedly isolated **interaction** can be modified without serious **side effects**. Such a belief is a consequence of the hitherto dominant **paradigm** of **lineal sequential determinism**.

Many human made disasters are results from such unforeseen feedbacks (C. FRANÇOIS, 1989). Some examples are acquired resistance of insects and pathogens to insecticides and synthetic drugs, negative results of irrigation schemes, economic measures fuelling inflation, etc...

One of the most dangerous aspects of this problem is that unforeseen consequences emerge only with a **time lag**, sometimes a very long one. Moreover, they may diffuse in unsuspected ways to many **parts** of the system. As a consequence, they can be quite difficult to control when they surface, specially when their true nature is still not yet clearly understood.

1260

FEEDFORWARD^{1) - 2)}

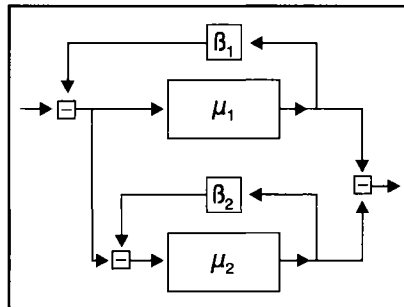
"**Information** that attempts to predict **disturbances** before they actually affect the system" (Adapted from M.C. JACKSON, 1992, p.99).

Information about past **events** can in many cases be ordered and used to **forecast** possible future **events**. Such a **knowledge** can then be used to try to correct the course of these forecasted **events**. The concept is fuzzily transferred from engineering.

M.D. RUBIN describes technical feedforward devices in the following terms: "Feedforward occurs when a part of the **input signal** is also fed around the **amplifier** and is in some way

combined with the **output** of the **amplifier** for further processing, in such a way that the **output signal** is *not* recirculated through the **amplifier**" (1968, p.18).

This is thus some kind of **buffer** device, used to damp possible wild **fluctuations**. "Forward" seems to imply the **intention** to **control** these **fluctuations**, whose possibility is foreseen.



negative-feedback amplifier with feed-forward.

1261

FEIGENBAUM's NUMBER^{2) - 5)}

FEIGENBAUM's number is related to **period-doubling sequences** in systems turning **chaotic** through the increase of **parameter a** in the difference equation $x_{n+1} = ax_n(1-x_n)$, which can also be written in its quadratic form $x_{n+1} = ax_n - ax_n^2$, where the second term is **nonlinear**.

R.V. JENSEN states: "As *a* is increased, the **long-time** motion converges to period – 8, – 16, – 32, – 64... **cycles**, finally accumulating to a **cycle** of infinite **period** for $a = a_{inf} \approx 3.57...$ FEIGENBAUM was able to prove, using a remarkable application of the **renormalization group**, that the intervals over which a **cycle** is stable decrease at a geometric **rate** of ~ 4.6692016 . The tremendous significance of this work is that this **rate** and other properties of the **period-doubling bifurcation sequence** are universal in the sense that they appear in the **dynamics** of any system which can be approximately modeled by a **nonlinear map** with a quadratic extremum. FEIGENBAUM's theory has subsequently been confirmed in a wide variety of physical systems such as turbulent fluids, oscillating chemical reactions, **nonlinear electric circuits**, and ring lasers" (1987, p.171).

It would be very interesting to see if this property conducive to the onset of **chaos** is also present in ecological, economic and **social systems**.

1262

FENETECISM²⁾

A general **taxonomy** of **living systems** based on their readily observable characteristics.

Feneticism recommends the use of the maximum number of known characteristics, but does not use any ponderation of the same. It tries only to **cluster** the species which present more common characteristics.

→ "**Cladistic analysis**".

1263

FIBONACCI SERIES^{2) - 4) - 5)}

An additive series of consecutive numbers whose ratios develop in the following way

This series was introduced by the Italian mathematician FIBONACCI in 1220.

As can be observed, every successive term of the progression 1, 1, 2, 3, 5, 8, 13, etc.,... is the sum of the two former ones.

On the other hand, the limit of the ratio's sequence is $(\sqrt{5}+1)/2 = 1.618...$, the so-called **golden section**.

Both the series and the **golden section** appear in numerous natural **structures** and seem to reflect opposite **constraints** in **field dynamics**. It thus reflects and explains the genesis of specific **forms**, as already shown for example by SCHIMPER, BRAUN and BRAVAIS for plants, in the 19th Century. It is also implicit in d'Arcy W. THOMPSON's "Growth and Form" (1916).

Its use in systemic **modelling** could probably be much developed. A.A DAVYDOV published in 1992 a very stimulating paper on this subject: "Theory of Harmony of Proportions and **Functions** in **Social Systems**" (1992).

1264

FIELD²⁾

A region of **space** endowed with a vectorial property corresponding to some specific **action**, f. ex. electrical, magnetic or gravitational.

This **concept** and **model**, elaborated by FARADAY and MAXWELL, replaced the **model** of a void **space** in which particles, charges or bodies attract or repel themselves through an instantaneous **effect**.

K.DE GREENE generally characterizes fields as follows:

" – All **matter** is inherently **unstable** and can be observed to **decay**.

" – A field in itself is continually fluctuating.

" – A field can cause an initially **homogeneous** system to develop new **spatiotemporal structure** (e.g. **dissipative structures**); the original system can become **unstable** everywhere in the face of infinitesimal **fluctuations**.

" – A single underlying force can, accordingly to the perspective of the **observer**, be manifested in apparently very different forms like the electromagnetic, weak and strong forces and perhaps eventually the gravitational force (to result in a grand **unified field theory**).

" – Attraction and repulsion are fundamental properties of forces.

" – There may be primary and residual forces.

“ – Forces have characteristic spatial **ranges** and strengths which may be very limited or immense.

“ – The basic constituents of **matter** interact via forces; a force binds **matter** together.

“ – Particles convey forces; a field emanates from a particle and extends over some volume of **space**” (1994, p.11).

Remains to be seen how the concomitant concepts of **space** and force, not to speak of **energy** and **time** could be defined or described in a not too circular way.

Various fields may interact in a complex way. As a result, a field can be **turbulent**.

In the concept of field, any **element** creates its own field, whose strength decreases with distance: a field implies a **gradient**. This idea can be extended to systems influence on their **environment**.

1265

FIELD AS A REPRESENTATION ²⁾

In a representation of a field- for ex. a static descriptive figure - “...the only real meaning of the lines is to represent the possible **paths** along which a third charged body would move (depending on its charge) if it were placed otherwise unhindered in the field”(J. Bryant, 1991, p. 3)

However, in the **Chladni** experiment with deposition of iron filings on glass surface placed above a magnetic field, the filings do not move anymore and the field is in some sense statically materialized in its **effect**.

1266

FIELD (Global) ²⁾

A combination of all local **variables** (J. THIERIE, 1990, p.442).

The Global Field is reflected by general **constraints** which affect the system as a **whole**.

J. THIERIE writes: “With regard to a system governed by a definite global kinetic **evolution** law (**coherence**), we are searching for... the consequences of introducing discernibility of **parts**, at the **level** of local evolution laws (**partitions** method).

“...the local **steady states** of such **partitions**, when kinetics is **nonlinear**, are not only fixed by the global **variable** and the kinetic values of **parameters** (as usual) but also by a combination of all local **variables**, called *global field*.

“This special **situation** leads to the possibility for local **bifurcations** to occur without risk for the global **stability**”.

“... those systems offer the unexpected property of deeply rehandling the **frequencies distributions** of the local **variables**, keeping a global **invariant** and **coherent behaviour**” (1990, p. 442).

This looks as yet another reformulation of **organizational closure**. Besides, it could probably be connected to **chaotic attractors** mathematics, which allows for local **randomness** within a global **determinism**. One may consider as an example the large physical and psychological **autonomy** of the living being, once the **constraints** of its basic biology are respected.

1267

FIELD of a system ²⁾

“The **phase-space** containing all the **lines of behavior** found by releasing the system from all possible initial **states** in a particular **set** of surrounding conditions” (W.R. ASHBY, 1960, p.28).

ASHBY states: “The concept of “field”... defines the characteristic **behavior** of the system, replacing the vague concept of what a system “does” or how it “behaves” (often describable only in words) by the precise **construct** of a “field” (Ibid).

It is however debatable whether it is always possible to obtain a full **knowledge** of “all possible **states**”, let alone of the full **phase-space**.

Nevertheless, ASHBY offered very interesting insights into the concept of field in his “Introduction to Cybernetics” (chap.9 “Incessant **transmission**”, where he describes the **set** of all the possible **transitions** of a system by **matrices**) (1956).

1268

FIELD (Social) ⁴⁾

“An **autonomous** microcosm within the social macrocosm”(P. BOURDIEU, 2000)

“Autonomous” is a perfect characterization of such a microcosm, as it means that it possesses (i.e. establishes and maintains) its own definitory **norms** and **rules**.

Social fields can be observed in all human institutions and **organizations**- as for ex. in religious **groups** of any kind, in business, in politics, in the arts and even in scientific disciplines within academic **structures**.

It is not proper to any **culture**, but it offers a wide arc of specific forms in accordance with environmental and historical conditions.

Recent research rises the possibility that some **precursor forms** of social fields may exist in some insect societies, as beehives and termites mounds.

Social fields could conceivably be related to **competition** for the occupation of the internal social **space**, and also to some kinds of age classes or **cohorts**.

1269

FIELD (Stability of a) ²⁾

According to W.R. ASHBY: “A field will be said to be stable if the whole **region** it fills is stable; the system that provides the field can then be called stable” (1960, p.49).

1270

FIELD: The Relativistic concept ³⁾

M. MARNEY and P.F. SCHMIDT write: “...EINSTEIN succeeded in formulating the fundamental equations of an analytical mechanics in which the previously intractable **distinction** between gravitational and electromagnetic forces no longer figured. In this novel conceptual format, the distinct **categories** of **space**, **time**, **matter** and **energy** were withdrawn and replaced by multiple **components** of a single formal **entity**: a unitary field characterized by a metrical geometry of the Riemannian type” (1976, p.189).

This is the reason why, in this dictionary, these four basic conceptual **categories** are co-defined in a tautological way.

1271

FIELD THEORY (Unified) ^{1) - 3)}

K.DE GREENE has proposed the following structure for a “Unified field theory”, giving for each contributing theory the main **constructs**.

“-Field theory in particle physics

Field

Force

Only totally meaningful

System-environment interaction

Attraction and repulsion

Inherent **instability**

“-Field theory of **critical phenomena**

Critical point

Correlation of elements

Trigger-and-ripple effect

Phase transition

Order parameter

Collective behavior

“-Chaos theory

Deterministic disorder

Inherent **unpredictability**

Source of new information

“-Synergetics

Micro-macro interaction

Spontaneous behavior

Order parameter (Extended)

Stochastic/deterministic behavior

Nonequilibrium phase transitions

Critical behaviors

“-Catastrophe theory

Catastrophe discontinuities

Exogenous forces (**Control parameters**)

Deterministic behavior

Equilibrium focus

Multistability

Hysteresis path

"-Dissipative structure theory

Thermodynamically open systems

Driving role of fluctuations

Stochastic/deterministic behavior

Nonequilibrium/far-from-equilibrium focus

Self-organization

Structural change

"-System dynamics

Informationally closed system

Feedback loop structure

Endogenous behavior generation

Deterministic behavior

Equilibrium/desequilibrium focus" (1994, p.18).

This quite complete synthesis emphasizes the **convergence** of a number of independently emerged theories and concepts within the general **frame of reference** of cybernetics and systemics and the corresponding **methodologies**.

Many interesting **linkages propositions** could be proposed and fruitfully explored

In a different spirit, the French biologist H. PRAT did propose a theory of the "Unitary field" in biology (1964).

1272

FIELD-FUNCTION ²⁾

"A **knowledge-set** which expresses the **relationship** between the **exogenous** factors present in the system's **environment** and the properties of the system's **parts**" (J.W. SUTHERLAND, 1974, p.37).

This concept, thus somewhat fuzzily defined, expresses that it is not possible to understand and explain the system without reference to its **environment**.

It seems however very difficult to establish precisely such a **knowledge-set**. Until now we do not have any very reliable method for tracking all the **elements** and **interconnexions** that should be integrated in such a field-function. This is, for example, a patent weakness of FORRESTER's **Systems Dynamics**, underlined by the controversial character of the famed **CLUB of ROME** studies.

1273

FIELDS (Interactions between) ²⁾

F. ROBB writes: "In general any **nonequilibrium distribution of matter/energy** can be described as a **flow field** embedded in a larger **flow field** with which it interacts. Where the two fields interact and the field forces are mild, no new properties emerge and the **processes** tend to **homogeneous equilibrium**. Where the field forces are strong, when the **gradient** is steep relative to the diffusion potential of the uncorrelated **interactions** of the **components** at the **interface**, then, subject to the **constraints** in the field, **emergent** evolutionary **behavior** is observed" (1990, p.390-91).

He adds, quoting R. SWENSON: "... in coherent fields, the **emergence** of **structure** is the most probable, indeed the inexorable, outcome of **change** in **time**. **Structure** building is the preferred route to **equilibrium** in what SWENSON calls an "incommensurable" universe. It is preferred because it is the fastest, the most efficient, way to maximize **entropy production**" (Ibid).

The connexion with PRIGOGINE's **thermodynamics of open systems faraway from equilibrium** is obvious.

Very similar ideas were also exposed under the guise of a theory of **vortexes** (or whirlpools) by the French engineer Ch. LAVILLE as early as 1950.

1274

FIELDS within FIELDS within FIELDS ^{1) - 2)}

This curious expression was the name of a journal published in the seventies by J. STULMAN. It has been again used by K.DE GREENE (1991, p.65) in his studies on the interconnections between short, medium and long **cycles**.

The **concept** has not been completely explored. It seems however to have the general **meaning of a hierarchy of action levels**.

Small and local **effects** are produced by small and local fields, which are numerous. They are however framed in spatially and temporally more extended fields, which in turn are still framed in ... and so on. An example is the variations of temperature under the dependence of various astronomical fields influences, themselves hierarchically ordered, from daily to seasonal, to sun activity, to secular and multi-millennium **cycles**, and even possibly galactic **effects** on the scale of geological ages.

The resulting general conceptual **frame** could be more or less formalized through **renormalization models**, i.e. with a degree of **self-similarity** through levels. (See "Self-similarity in WEIERSTRASS functions").

However, the use of such **models** for **forecasting** is problematic, as it must be applied to very **complex chaotic systems** (even if they remain somehow **deterministic** in a limited sense).

1275

FIGHT OR FLIGHT RESPONSE ⁴⁾⁵⁾

A behavioral response elicited mainly by the reaction of the limbic **level** of the **brain** when the individual is challenged by some external aggression.

The French biologist H. LABORIT developed a comprehensive study of the subject, under the generic term "Agressology", whose roots are biological and physiological (1970, 1976).

→ **Brain; Imprinting; Stress**

1276

FIGURE-GROUND ^{3) - 5)}

"The characteristically unequal emphasis in human visual **perception** on a figure, which stands out against an undifferentiated **background**, which merely contributes to that **perception**" (K. KRIPPENDORFF, 1986, p.30).

This is a basic condition in **Gestalt theory of perception**. It has been used by many artists, as for example M.C. ESCHER, to create optical illusions.

The concept is not merely limited to visual **perception**. KRIPPENDORFF observes that the same "...unequal emphasis is found in the **distinction** between a word and its **context**, between an **organism** and its **environment** or between **pattern** and **chance**" (Ibid).

He also states that "... visual examples of figure and ground reversals... are the equivalent of paradoxes" (p.31). **Double-bind** statements illustrates the same point in logics.

From a systemic viewpoint it is significant of the usefulness of **subsystems** good identification, and of making clear the difference between the system and its **environment**.

Janet McIntyre suggests that "when communicating in the caring professions we need to be constantly aware of this figure/ground nexus.

The **analogy** can help us to understand that the **perception** of the same **situation** can differ, depending on what you are concentrating on" (1988, p. 113)

Using the figure-ground as an illustrating **metaphor** can be quite helpful in psychological and psychiatric **situations**, as the "patient"-does not live isolated from his/her **environment**.

Even conflictive **socio-cultural issues** could be usefully looked at in this way.

In her paper McIntyre also draws analogies with other multi-facets **models**, as Mc LUHAN and POWERS tetrad and DE BONO six thinking hats (1989)

see figures next page

→ **Embedment**

1277

FILTER ^{2) - 3)}

Any device that selects **inputs** in a system.

No system could ever cope with the totality of the potential **stimuli** it could receive from the global **environment**: its "fuses" would immediately "blow out". Its **functional** characteristics depend precisely on the more specific **environment** whose **inputs** are significant for it.

Any system is however shaped from its genesis by a **set of rules** that will first define with precision what is acceptable for it and next, in a progressive way establish which **classes** of **inputs** it will finally accept, within the **range** of the acceptable ones.

Figure: see entry **FIGURE-GROUND**

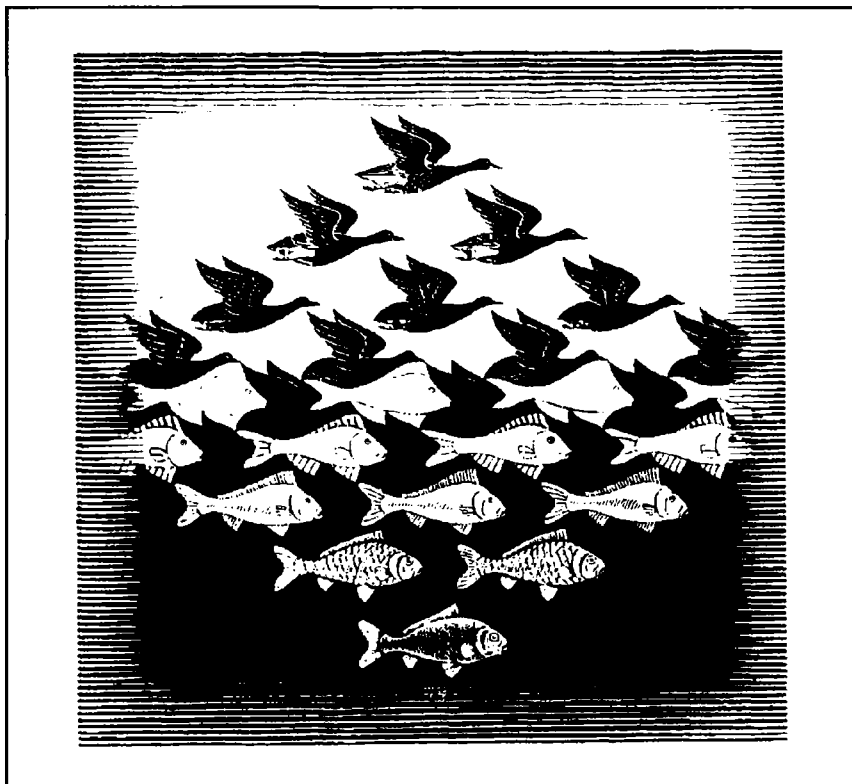


Figure-Ground
An engraving by M. ESCHER

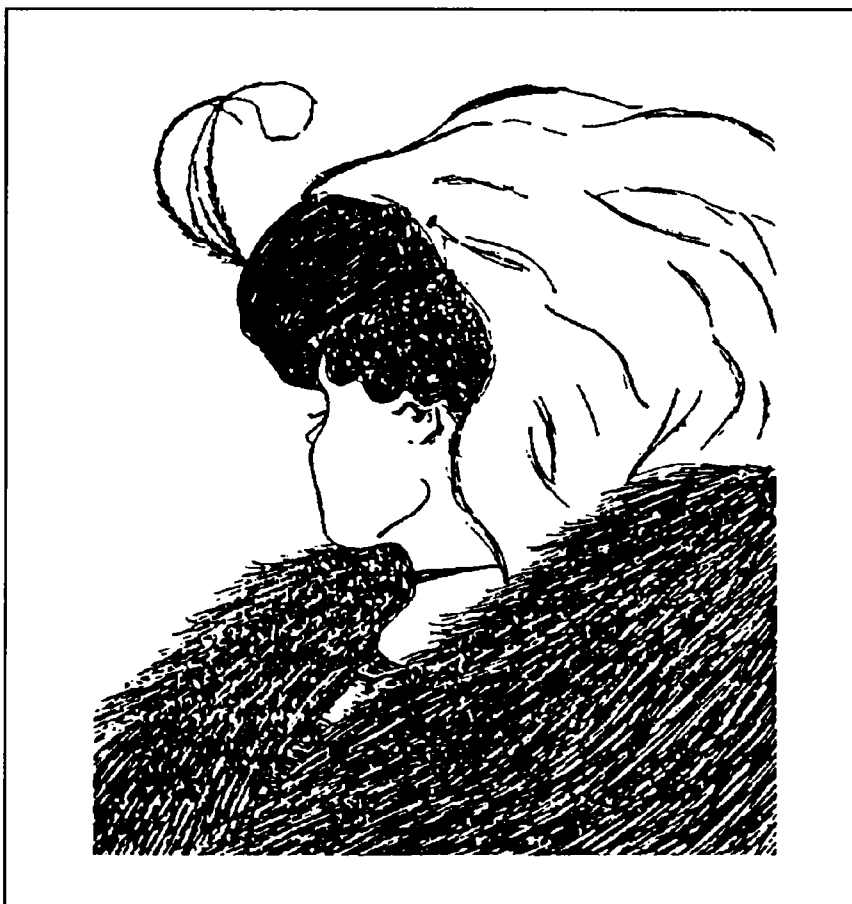


Figure-Ground: The well-known "Old-lady", "Young-lady", teaser

This **process of constraint** requires and produces the construction of the selective devices called filters.

Filters can be adaptive to different **values of stimuli**: it is for example the case of the eye's pupil, which may contract or expand within an acceptability **range**, according to the intensity of light.

Any **communication** which is not merely a blind **interaction** is based on filters (or **constraints**) that define a **language** of shared meanings (K. BERRIEN, 1968, p.113).

1278

FILTRATION^{1) - 2)}

"The **selection** of a **subset** for **transmission** to a **receiver**, from the **set** of **messages** intended for him" (R. ACKOFF & F.E. EMERY, 1972, p.191).

ACKOFF and EMERY add: "An intermediary may filter **messages** with the intention of better serving the **receiver's purpose**, as in transmitting only **messages** that he believes are of value to the **receiver**. Or the intermediary may filter for its own or another party's **purposes**. When it does so, it engages in censorship" (ibid).

In fact, the concept of filtration is much more general than this. Any **complex system** is pre-conditioned to admit only useful **inputs** from its **environment** and use numerous filtration devices to protect itself.

From a different viewpoint, as observed by D. DUBOIS, any **modelization** implies selectively filtering out properties of the **concrete system**.

"Any **model** is constructed by reference to a particular **scale** of the system, without taking in account the details on the lesser **levels**. Only *some* properties of these lesser **levels** are considered" (1990, p.75).

→ **Structural differential**

1279

FINALITY^{3) - 4)}

Goal or **objective** that a system *seems* to pursue, in spite of **disturbances**, induced by its **environment** or of **endogenous** origin.

In systemics this concept does not imply intentionality. It merely characterizes an observed **behavioral pattern**, which appears to be recurrent or permanent. It is thus neither **mechanicist**, nor transcendental.

Finality, in this systemic-cybernetic meaning, is characterized by **regulation** around definite **standards**.

Intentional **behavior** seems proper only to **human systems**, as claimed for example by J.L. LEMOIGNE, who speaks of "self-finalization" as human capacity to define own **goals**. This could possibly be extended in a limited sense to superior animals.

As observed by E. SCHWARZ, in no case does **teleonomy** - a notion more immune to conceptual distortions - imply some **cause** in the future for the present **state**. (1993, p.6) Thus any science fiction **time paradox** is avoided.

In a different way, the French biologist J. MONOD considered that the complex organization of the human **brain** entails a kind of predictive capacity and accordingly, some measure of **control** for the future of its owner. If alternative possibilities exist, then **decision making** makes sense, as well as **goal-directness**, **goal-seeking** (and **purpose**)

→ **Teleonics; Teleonomy; Teles**

1280

FITNESS¹⁾²⁾⁵⁾

Selective **value** of some characteristics of a system, a member of a species or a species as a **whole**.

Of course fitness is a relative concept. It cannot be understood without some specific **environment**, as for example ecological or enonomic.

However its meaning is quite general. It applies not only to individuals, but also to **populations**. As conditions change, the transient nature of fitness becomes obvious, be it for dinosaurs at the end of mesozoic, or horse driven coaches at the beginning of the 20th Century.

Fitness is now researched experimentally through "**evolutionary robotics**" (D. FLOREANO, 1996 and 2002 and M. SIPPER & J.A. REGGIA, 2001)

Floreano "computers **robots**" (i.e. electronic **models** of robots) and their **behavior** is discussed extensively in a "written symposium" ("Symposium écrit") on "**artificial evolution**", organized by the Institut de la Méthode (Lausanne University, Switzerland)

→ **Evolution (artificial), Paralled distributed processing, Robot (Khepera), Weights (Synaptic)**

1281

FITNESS CRITERIA^{1) - 3)}

There are no **absolute** fitness criteria. All criteria are related to some characteristics, deemed positive or negative, according to specific **aims**, but possibly insubstantial or irrelevant from another **viewpoint**.

As an example, A. JACQUARD observes: "The very expression "improvement of species" is perfectly illusory. We did not *improve* wheat, nor cows, nor horses. We have improved wheat's capacity to use some fertilizers (note: in some regions), cows capacity to produce milk (note: under specific conditions), horses capacity to run fast (note: mainly on race tracks)... But may we really boast about having improved maize or horses, while we have rendered them unable to survive without us?" (1978, p.162).

As to fitness as a **criterion** of "survival of the fittest", it does not amount much more than the tautological "survival of the survivors", the survivors being declared the fittest... because they survived.

1282

FITNESS FUNCTION²⁾⁵⁾

The criteria by which **sets** of **rules** can be selected to create an evolutionary **process** aimed at evolving a **self-replicating automaton**.

M. SIPPER and J.A. REGGIA (2001) devised a "fitness function composed of a **weighted** sum of three measures: a **growth** measure (the extend to which each **component** type generates an increasing supply of that component), a relative **position** measure (the extend to which neighboring components stay together) and a replicant measure (a function of the number of the actual replicatory **elements** present)

With the right fitness function, **evolution** can turn rule sets that are sterile into ones that are fecund; the **process** usually takes 150 or so generations".

"The ability to replicate without a **self-description** may be relevant to questions about how the earliest biological **replicators** originated. In a sense, researchers are seeing a continuum between non-living and living **structures**" (p. 31-35)

→ **Artificial life; Cybernetics (2nd); Evolution (Artificial); Game of life (Conway); Neural network; Paralled distributed processing; Weights (Synaptic)**

1283

FITNESS in REPRESENTATION^{1) - 3)}

According to von GLASERSFELD: "The substitution of the concept of fit (and its dynamic corollary, *viability*) for the traditional concept of *truth* as a matching, **isomorphic**, or **iconic representation** of *reality*, is the central feature of the theory of **knowledge** I have called **Radical Constructivism**" (1988, p.77-8).

The quest for fitness is the **activity** of **observers**, who postulate the existence of reality but also recognize that is cannot be fully transparent to them.

Of course, fitness in **representation** thus becomes unavoidably **empirical**, pragmatic, relativistic and contingent.

A similar concept was developed by the Swiss epistemologist F. GONSETH ("Idonéité") (1945).

1284

FITNESS: rigid, adaptive, evolutive or what?^{1) - 3)}

The concept of fitness of the **organization** or **behavior** of systems has been discussed by various authors.

B. BANATHY for example advocates the necessity of a good fit for any project, while G. BROEKSTRA writes "... the rationality of **equilibrium** became associated with the order-through-fit principle. It was understood that **fluctuations** in the form of misfits, inconsistencies, paradoxes, or contradictions, had to be damped or suppressed. In this way, the fit **paradigm** became a unitary approach driving an **organization** toward a particular **stable attractor state (configuration)**" (1992, p.1025).

Within this **frame** the **concept** of fitness can carry two different **meanings**:

- the first one, strong and even absolute, does not admit any "**deviation**". This is the hallmark of authoritarian bureaucracy and it sometimes ends with the destruction of the system.

- The second one, weaker and more realist, admits some **fluctuations** in order to maintain **dynamic stability** within more or less narrow **limits**. This is the adaptive approach.

BROEKSTRA goes further and writes: "However, although a tight fit may lead temporarily to excellence... in the long run fit may lead to failure. Therefore a new way of thinking about organizing is called for, one that encompasses this paradox. The old fit perspective does not disappear, but is absorbed in a more comprehensive theory...

... the **non-equilibrium**, evolutionary **paradigm** of **self organization** as represented by **chaos** systems theory, and in particular PRIGOGINE's theory of **dissipative structures**, in short, the **Chaos** hypothesis, constitutes a powerful **change of language**..." (Ibid.).

While individual systems may survive long time only by adapting, collective systems as species or **organizations** do survive in the long run only if they *evolve*.

Fitness becomes than an ever provisional result of the capacity to construct working higher **complexity** and restaure **dynamic stability** when, after wild **fluctuations** due to massive **inputs** (of **energy** or **information**) coming from a changing **environment**, the system undergoes **dissipative structuration**, **bifurcations** and an **emergence process**.

This leads to the **chaos** and **criticality** viewpoint, thus stated by St. KAUFFMAN, (quoted by R. RUTHEN): "It turns out that in a wide variety of coupled systems the highest mean fitness is at the **phase transition** between **order** and **chaos**... The bold hypothesis is that complex **adaptive systems** adapt to, and on the edge of **chaos**... It now begins to appear that systems in the complex **regime** can carry out and coordinate the most complex **behavior**, can adapt most readily and can build the most useful **models** of their **environment**" (1993, p.117).

It finally seems that fitness is quite elusive and ever changing, confirming BROEKSTRA's **understanding** and BANATHY's concept of **co-participative** and necessarily permanent **design**.

→ **Equilibrium (Punctuated)**

1285

FITNESS VALUE⁵⁾

A measure of the more or less satisfactory correspondence of a problem solution with some stated **goal**. (adapted from P. DENNING, 1992a, p.12).

This concept is referred to the use of **genetic search algorithms**, by which trial solutions are cross-bred, allowing "only the *fittest* solutions (those accorded the highest **values**) to survive after several generations" (Ibid).

In this way "biological **analogies** in computing and **information analogies** in biology" are explored (Ibid).

1286

FIX (Quick)¹⁾

Any local or specific **adjustment** which does not take into account the systemic nature of the **problem** it aims to solve.

Quick fixes frequently suppress some terminal **effect** of a global maladjustment. In many cases, the ill **effect** reappears after some time, or propagates in a different way to another **part** of the system. The tendency to quick fixes is widespread in front of social and economic trouble as well as in case of **machine** or **man-machine** maladjustment, and even sometimes in medicine.

It should be replaced by more thoughtful **methods**, based on a better **understanding** of the – sometimes hidden – complex **interactions** within the system.

1287

FIXED POINT²⁾

The terminal point of a **trajectory** in the **state space** of a system (J. CRUTCHFIELD et al, 1989, p.41).

CRUTCHFIELD et al explain: "... this fixed point is an **attractor**... Any system that comes to rest with the passage of **time** can be characterized by a fixed point in **state space**. This is an example of a very general **phenomenon**, where losses due to friction or viscosity, for example, cause orbits to be attracted to a smaller **region** of the **state space** with lower dimension" (Ibid).

In fact, the fixed point is generally the **final state** of the system, when it undergoes no more **transformations** (as for example a physical system, like the pendulum) or is not anymore a system (as in the case of **living systems**). Such a final fixed point is also sometimes called a **sink**. However, this word also

has another quite different **meaning**. A fixed point which attract in one direction and repels in another is called a **saddle**. A point of origin is a **source**.

1288

FLEXIBILITY^{1) – 4)}

1. "Capacity of an **organization** to suffer limited change without severe disorganization" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.41).

2. Capacity of a system to adapt itself to strong **perturbations** by **switching** from one **domain** of **dynamic stability** to another (Adapted from C. HOLLING – 1976).

In another definition K. SAYRE emphasizes the relation between the system and its **environment**. He also uses the somewhat controverted concept of **negentropy**: "... the capacity of an **organism** to establish efficient couplings with its **environment**, under a range of different conditions, through which **negentropy** can be obtained to support its **growth** and **metabolism** and to control its **response** to **environmental** conditions" (1976, p.117).

This concept is akin to W.R. ASHBY's **Law of Requisite Variety**. Flexibility also seems to be a condition for better **adaptation**, and probably **evolution**.

SAYRE quotes J. HERRICK, who wrote: "Progressive organic **evolution** may be defined as **change** in the direction of increase in the **range** and **variety** of **adjustments** of the **organism** to its **environment**... This involves increase in the **complexity** of **structure**, ensuring **sensitivity** to a greater **variety** of **environmental energies** and more refined sensory analysis" (1946, p.469).

Thus, increased flexibility, through "increase in the **complexity** of **structure**" is also related to **dissipation** of **energy** and this early insight has been later vindicated by Prigoginian **dissipative structuration** in systems **far away from thermodynamic equilibrium**.

Another definition given by H. VOLBERDA and T. DE LEEUW applies somewhat more restrictively to human **organizations**: "... the degree to which an **organization** possesses a **variety** of actual and potential procedures, and the rapidity by which it can implement these procedures, in order to increase the **control** capability of the **management** and improve the controllability of the **organization** and the **environment**" (1992, p.1083).

According to G. BATESON: "Flexibility may be defined as uncommitted potentiality for **change**" (1973, p.473).

The most stable systems (or **organizations**) are *not the most rigid ones*, but those which can oscillate with some **amplitude** within the **limits** of their conditions of **dynamic stability**.

FEIBLEMAN and FRIEND give the following example: "A river is a flexible **organization** (i.e. system) since its course and dimensions may be altered to a very great extent without damage to its essential **structure**" (Ibid).

Flexibility is maxima in very decentralized and **heterogeneous** systems. However, an excess of flexibility may lead to loss of **cohesion**, incoherence and break up of the system.

In R.L. ACKOFF's opinion however: "There is no limit to the amount of flexibility that can be designed into a system. The more uncertainty an **organization** faces, the more flexibility should be designed into it" (1988, p.245).

And: "The more flexible an **organization** is, the more it can redesign itself... Therefore, the ability to learn and adapt rapidly and effectively must be designed into **organizations** intended to be flexible" (Ibid.).

→ **Autonomy, Resilience**

1289

FLEXIBILITY (Distributed)^{1) – 2)}

As stated by W.R. ASHBY and, later on by G. BATESON (1973, p.474): "The **distribution** of flexibility among the many **variables** of a system is a matter of very great importance".

This is a logical consequence of the character of **complex systems** of being interconnected **networks**, which allows, to a point, for redirected compensation of local **perturbations**.

H. SELYE's **General Adaptation Syndrome** reflects the same fact, and so does the reconstruction of cerebral **networks** which may sometimes take place after a cerebral haemorrhage.

Distributed flexibility seems to be a very basic property of all social systems, even those which are strongly integrated.

1290

FLEXIBILITY (Loss of)¹⁾

Loss of flexibility in a system is a pathology.

G. BATESON explains it in the following way: "When under **stress**, a **variable** must take a value close to its upper or lower **limit of tolerance**, we shall say ... that the system is 'up tight' in respect to this **variable**, or lacks flexibility in this respect.

"But, because the **variables** are interlinked, to be up tight in respect to one **variable** commonly means that other **variables** cannot be changed without pushing the up-tight **variable**. The loss of flexibility thus spreads through the system. In extreme cases, the system will only accept those changes which change the **tolerance limits** for the up-tight **variable**". This is related to SELYE's **General Adaptation Syndrome**.

If flexibility is totally lost, the system will eventually break up.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Flexibility must be exercised unless it may be lost. In BATESON's words: "...if a given **variable** remains too long at some middle **value**, other **variables** will encroach upon its **freedom**, narrowing the **tolerance limits** until its freedom to move is zero or, more precisely, until any future movement can only be achieved at the price of disturbing the encroaching **variables**" (1973, p.479).

This is particularly obvious in biological systems, but could seemingly be applied in mental, psychological and social ones.

1291

FLEXIBILITY of a MODEL ¹⁾ - 5)

The possibility of applying the same model (with slight modifications if needed) to a number of different kinds of **situations** or systems.

This can be understood in various ways:

- The possibility to apply the model to different **levels of complexity**. A good example is the general model of **living systems** elaborated by J.G. MILLER (1978).
- The possibility to apply it to different kinds of systems hypothetically endowed with some common properties. A good example is M. EIGEN's **hypercycle** model (1979).

1292

FLICKER NOISE ¹⁾ - 2)

An irregular **criticality signal** corresponding to the triggering of a timely **variety** of sudden **changes** in unstable **composite systems**.

P. BAK and K. CHEN state: "...flicker noise suggests that the **dynamics** of the system are strongly influenced by past **events**. In contrast, **white noise**, a **random signal**, implies no **correlation** between the current **dynamics** and past **events**" (1991, p.28).

They add: "The theory of **self-organized criticality** suggests a rather general interpretation: flicker noise is a superposition of **signals** of all **sizes** and durations - **signals** produced when a dynamic (**composite**) **system** in a **critical state** produces chain reactions of all **sizes** and durations" (Ibid).

The flicker noise expresses an inverse relation between the **amplitude** of **fluctuations** and their number. Small **fluctuations** are very frequent and numerous, while giant ones are very rare.

The concept has been applied to earthquakes by B. GUTENBERG and Ch. RICHTER. The GUTENBERG-RICHTER law says that: "The number of earthquakes each year that release a certain amount of **energy** E, is proportional to 1 divided by E to the power of b where the exponent b is about 1,5. The exponent b is universal in the sense that it does not depend on the particular geographic area. Hence, large earthquakes are much more rare than small ones" (BAK & CHEN, p.29).

The comparison for example, with stock's quotations **fluctuations**, **populations variations**, or even social unrest, leads to the insight that small and frequent releases of tensions avoid the crossing of more dangerous **instability thresholds**. When they do not occur or are much delayed a **runaway event** becomes unavoidable and leads to an explosive release of pent-up **stresses**.

BAK and CHEN report that B. MANDELBROT has found **fluctuations** in the DOW JONES index, similar to flicker noise (Ibid).

→ **Criticality; Elliot wave**

1293

FLIP-FLOP device ²⁾ - 5)

Any **control** that switches between two opposite positions.

Most flip-flops are electronic **circuits**, but many natural systems are also able to switch through **phase transitions** from one **state** to another. In these cases however, it is frequently impossible to pinpoint any specific **trigger**.

1294

FLOCK

→ **School; Shoal, Swarm**

1295

FLOCKING ¹⁾⁴⁾⁵⁾

A massive **emergent** collective **behavior** among animals and some micro-organisms through which they align their movements in ordered **patterns**.

More generally it is a typical **behavior** of numerous elements in originally **random interaction** within a confined **space** (See M. BUCHANAN, 2000).

Flocking is observed in birds flights, in fish **shoals**, in some bacteria and seems even to correspond to atoms orientation in magnets.

It has been modeled by C. REYNOLDS through a computer **program** applied to a number of "creatures" called **boids**.

REYNOLDS' **algorithm** imposes them three simple **rules**:

- Try to match your direction with your neighbours
- Head for their average **position**
- Don't collide

Flocking appears as an **emergent** property in such a setting.

It appears to be an adaptive collective condition corresponding to a more efficient global use of **energy**. As a behavior it leads to the **emergence** of complex systems at a higher **level**, in accordance with PRIGOGINE's theorem of **minimum entropy production** and HAKEN's so-called **slaving principle**

T. VICZEK, of Eötvös University, in Budapest, and some American researchers, have developed mathematical **models** of this quite frequent **phenomenon** (B. SCHECHTER, 1999, p.30-33)

→ **Crowd Physics; Order from Noise; School; Swarm**

1296

FLOW ¹⁾ - 2)

A displacement of **energy** or **matter** that tends to reduce a difference of **level** or **gradient** between a system and its **environment** or among **subsystems** within the system.

"Flows are defined in terms of the **rates of change** of the **value** of the systems **attributes**" (J.van GIGCH, 1988, p.15).

A flow can be maintained in a permanent way only when the difference of **level** or **gradient** between the **source** and the **sink** is maintained.

For example our planet will be able to maintain and create organized **structures** and dissipate heat toward the external space only as long as the sun maintains its capacity to produce **energy** at a more or less constant **level**.

Any flow involves some work, but altogether a degradation of the **energy** it carries. Any flow corresponds to a well defined **gradient**, to which it is said to be conjugated.

1297

FLOW CHART ²⁾

The graphic **representation** of a **sequence of operations**.

The study of flow charts can be useful for the **evaluation**, eventual simplification and/or restructuration of complex **processes**, particularly in **planning**. See specifically "PERT".

1298

FLOW DIAGRAM ²⁾ - 5)

A feature of J. FORRESTER's **Systems Dynamics**, connecting **levels** (i.e. **states**, in FORRESTER's wording).

FORRESTER writes: "The flow diagram should show how **levels** and **rates** are interconnected to produce the **feedback loops** and how the **feedback loops** interlink to create the system" or still "The flow diagram should show the **level**, **rate** and auxiliary equations and how they are interconnected" (1973, p.7-1).

In **Systems Dynamics**, flows are carrying **matter** or **information**.

1299

FLOW LINE ¹⁾ - 2)

"A transmission line of **information structures** that have engrained within them means of dealing with the **environment**" (S. GOONATILAKE, 1991, p.1).

This concept is inspired by F. VARELA: "(The) **structures** are richly interconnected and the **autonomy** of the lineage is maintained through **time**. The **information** which is transmitted may generally be classified as genealogical **communication**, which conservative **structures** are transmitted down through different **channels**" (Ibid)

This means that flow lines are vehicles for species and societies **autopoiesis**, within **evolution**.

According to E. JANTSCH such **channels** could be DNA, a neural **memory** or **artefacts** (1980, p.197).

The concept of flow line tries to synthesize the very general **process** through which all types of systemic characteristics are conserved and transmitted through **time**.

GOONATILAKE enriches the concept as follows: "The flow lines vary as to their degrees of **rigidity** or **flexibility**. The inner cores are less flexible than the outer ones. The outer cores respond to the **environment** more rapidly than the inner core. The inner core, however, limits the nature of **responses** of an outer core to **changes in the environment**" (Ibid, p.3).

He distinguishes three different types of flow lines:

- the genetic ones;
- the neural-cultural ones;
- the exosomatic ones (p.118-120).

The first line is basic for the existence of the second and the second in turn is the condition for the **emergence** of the third one. "One could depict the evolving **information** flow as a core which gradually adds on concentric **envelopes**" (p.132-3).

And: "In all flow lines **categories** there is a phylogenetic tendency for an increase of **information** and **complexity**" (p.131).

He also observes that **exosomatic** (i.e. technological and cultural) flow lines in human societies tend swiftly to escape to human **control** and to become a very complex **set**, with its own internal logic. Quoting D. MICHIE he states: "Increasingly, the **information** line from computer to computer would assume an **autonomy** of its own, in view of the extensive need for **growth** of new **information** sources and large **data** bases" (Ibid, p.116). We have already witnessed some incidents of this type, as f. ex. the "automatic" crashes in stock markets provoked by cascades of pre-registered stop orders. The Internet is starting to exhibit such **autonomy**, a feature that does not please everybody!

GOONATILAKE also notes that flow lines **co-evolve** with the **information environment** (p.125).

In some sense, his work is convergent with SABELLI's **process theory** and MEYER's **evolutionary acceleration**.

1300

FLOW (Linear)²⁾

A flow whose intensity is directly proportional to the difference of **level** or **gradient** between the **source** and the **sink**.

In those cases in which the **gradient** remains stable, the flow remains steady and the system that uses it is able to maintain its **organization**, or **heterogeneity**, thanks to the steadily absorbed **resources**. Under such conditions, the system evolves toward a **state** in which it maintains its properties through **time**: the so-called **steady state**.

Under the **steady state regime**, the specific production of **entropy** tends to a minimum compatible with the nature of the system's **organization**.

1301

FLOW (Tense)²⁾

A flow that works in a constant stable way without using counter-**aleatory reserves**.

Tense flows are a possibility when the **environment** provides permanently the needed **resources** without excessive variations.

It implies the existence of an internal **adaptive mechanism** within the system that allows it to increase or decrease (within **limits**) its use of the resource in accordance with its **availability**.

It has been discovered for instance that fish, molluscs and shellfishes (crabs, lobsters) have a low **level** of blood oxygenation which allows them when needed, to survive in more or less anoxic environments.

1302

FLOWS and STOCKS²⁾

No flows can exist without the existence of **sources** supplied with stocks, renewable or not.

As to **energy**, the presence of a **gradient** is essential.

As to **matter**, the stocks or **reserves** must be freely available and renewable.

As to **information**, the "stocks" can be **data** banks, behavioral **algorithms**, acquired **knowledge**, etc... In these last cases, there is a curious peculiarity: The flow of **information** does not impoverish the **sources**.

1303

FLOWS SLOWDOWN²⁾

In **complex systems**, flows of **energy** and **matter** are slower than in simpler systems.

Complexity of the system, for example in **ecosystems**, results in an ordered sharing of available **resources** in **energy** and **matter**. Such **order** tends to be **hierarchical**, with some **dominant** species in **control** of the power flow in the **circuit** (but also maximally depending on it).

In this way, the flow becomes *sequentially* divided, or cascaded, between numerous users and more **organization** is obtained with the same final **level** of **entropy** production. In H. ODUM words: "Unless special **energies** are directed to prevent succession, the **complex system** with its specializations performs more work **functions** for a total effort and displaces systems whose **energies** are going into **storage** instead of into useful work for competitive **survival** and **dominance**" (1971, p.112).

As a result, ODUM takes a dim view of man's general "simplification" of the natural systems by suppression of many of their participants. It would however seem that "useful work for competitive **survival** and **dominance**" is what precisely leads **human systems** to this simplification!

1304

FLUCTUATION^{1) - 2)}

A more or less periodical spurt in the **behavior** of a system or a **process**.

Fluctuations of the main **variables** are essential for the **equilibrium** of any system.

There are however two basic, and quite opposed types of fluctuations. In I. PRIGOGINE's words: "Fluctuations on a sufficiently small **scale** are always **damped** by the **medium**. Conversely, once a fluctuation attains a **size** beyond a **critical** dimension, it triggers an **instability**" (1976, p.119).

The first type corresponds to systems in **dynamic equilibrium**. In such cases, fluctuations happen in a more or less **periodic** way and with limited **amplitude** (i.e. tending to **damping**). Indeed, the main condition of **dynamic stability** is that no **value** of any **variable** should cross any defined **critical threshold**. Various types of fluctuations may interfere with each others, producing for the **observer** confusing and quite unpredictable **trajectories**. However, the **global behavior** of the system remains regulated or controlled.

The second type of fluctuations is dominated by **positive feedback**, thus supplied with continuously increasing **energy inputs** from the **environment**, sometimes motored by the system itself. In such cases, the system runs away from its **homeostatic trajectory**, as the fluctuations become ever increasing until a **critical threshold** is crossed. A discontinuous **transition** is then triggered through a last infinitesimal increase of the fluctuation. This may lead either to the demise of the system, as mega-fluctuations can be very destructive, or to a **process** of **bifurcations** and **dissipative structuration** that carry the system towards a higher **level** of **complexity**. (PRIGOGINE's "order through fluctuations"). This author observes: "Unlike **equilibrium** systems, non-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

equilibrium systems do not have a general prescription, like the EINSTEIN formula, to describe the fluctuations. **Nonequilibrium** fluctuations are highly specific" (1984, p.58).

An intermediate **situation** is however possible when the **stability domain** of the system is complex, consisting of various **domains of attraction** which correspond to different internal or external conditions. In such cases, the crossing of a **local stability threshold** implies only a **change of domain**, while global **dynamic stability** is sustained. As emphasized by C. HOLLING this type of fluctuations *enhances dynamic stability*, notably in complex **ecosystems**, whose general **resilience** is thus increased (1976, p.81-4).

1305

FLUCTUATION (Critical)^{1) - 2)}

I. PRIGOGINE states: "We have shown that it is only in the case of **linear systems** that the small fluctuation can be described by POISSON's formula... For **nonlinear systems far-from-equilibrium**, the **distribution** law of the fluctuations of the reacting substances is not that of POISSON.... the fluctuations are **local events**, and one must consider a supplementary **parameter** scaling the extension of the fluctuations. This will be a new characteristic length determined by the intrinsic **dynamics** of the system and independent of the dimensions of the reacting volume. Thus, there is an essential difference in the **behavior** of the fluctuations depending on their spatial extension... This... implies that... only fluctuations of a sufficient extension can attain enough importance to compromise the **stability** of the macroscopic **state** considered.

"Thus our recently developed theory leads quite naturally to the notion of a **critical fluctuation** as a prerequisite for the appearance of an **instability**" (1976, p.117).

PRIGOGINE also states: "It is the fluctuation that can force the system to leave a given **macroscopic state** and lead it on to a new **state** which has a different one" (1976, p.39).

In still another paper, I. PRIGOGINE et al. write: "In dissipative **structures**,... the macroscopic **order** which arises after an **instability** is determined by the fastest growing fluctuation" (1975, p.38).

1306

FLUX²⁾

"A generalized, ordered or **turbulent** streaming" (D. Mc NEIL, pers. comm.).

While generally used as a synonym for "**flow**", this latter is, according to Mc NEIL, a stream of a substance.

1307

FOLD²⁾

A singularity in a 3-dimensional **space** that may generate a **discontinuity** in a **process' behavior**.

The fold-catastrophe is the simplest of the seven elemental **catastrophes** in R. THOM's theory. It has been used in numerous disciplines to modelize sudden shifts between two quite different types of **behavior**.

1308

FORAGING THEORY²⁾⁵⁾

An ecological theory that explains important aspects of animal **ecology**.

Foraging theory's main **rule** is that "animals make **choices** that maximize their "Benefit per unit cost" i.e....they'll expend food gathering **energy** in ways that yield the best energy return"(R. CHALMERS, 2000, p. 39)

Chalmers comments: "The longer a forager exploits one **patch**, the lower the returns will be, until this patch is overgrazed and worthless"...and..."...the optimal **strategy** is to move on when the **rate** of return from a particular patch falls below the average rate over the whole region. This is the **marginal value theorem**...formulated by Eric CHERNOV in 1976"(Ibid.)

In other words, foragers- which are in some sense **parasites** of their **environment**- always try to maximize their rewards.

Of course, the "**whole region**" value must be monitored, which is more easy for an organized **group**...but implies also some **costs**.

It seems that these concepts could be applied in economy. They are surely relevant in cultural anthropology for semi-nomad **groups**. They could also explain the growing trend toward economic migrations, in our time.

Foraging behavior is in fact systemic in a very general sense.

It is clearly associated with the relation between costs and **yield**. A good example is the search for an optimal relation between obtaining relevant **information** and the cost to obtain it, in search time as well as in money.

This can be expressed as "benefit per unit cost".

→ **Commons; Density; Density of occupancy; Hexagonal space filling; Parasitism**

1309

FORECAST (Conditions of)^{1) - 3)}

Anticipation of **events** supposes a **knowledge** of former causal **sequences** and of the general (i.e. **environmental**) conditions of their occurrence. Moreover, two more or less complementary hypotheses are needed:

- that we really know all the relevant conditions in which former causal **sequences** were produced;
- that no new **factor** will appear

This would do for **dynamically stable** systems.

Still, we can never be sure that some **instability threshold** will not be crossed and/or that **bifurcations** will not take place, leading to **dissipative structuration** (i.e. **emergence** of "something" different) or to **chaos** (appearance of one or more unsuspected alternate courses).

Forecasts are most generally based on logical deduction. However, as noted by E. JANTSCH: "Logical deduction is always **linear** and partial by its very nature, since it tends to isolate a single aspect of reality" (1975, p.203). As a result, traditional ways of forecasting are of dubious value (and in many cases little more than a mirror for wishful thinking). Even more sophisticated ones are still far from being totally trustworthy.

1310

FORECAST (Limits to)^{1) - 3)}

Forecast and **planning** are possible at different **time** horizons.

Short term forecasts are needed for immediate **action**, but their results are useful at **medium** and at **long term** only if correlated to these last, since **short term action** must be non-contradictory with **medium** and **long term trends**.

These last produce the needed **directive correlations**, but would also be useless if not providing a satisfactory setting for **short term** forecasting and action.

M.P. SCHUTZENBERGER gives an example of this, which he relates to so-called "spans of foresight": "If the man coming down the hill plans each next move according to the details of the next hundred feet he will do better than if he were to plan only over the next ten feet. The spans of foresight are here a hundred feet and ten feet respectively" (1969, p.210).

Of course, **planning** for the next hundred feet is efficient only if a sufficient **knowledge** exists of what is going to happen within the next ten feet and if a satisfactory **integration** of both forecasts can be obtained.

In any case, forecast should be taken with some skepticism, since we never know the whole of a **situation**, nor all the complexities of the **dynamics** of its possible **transformations**. As stated by G. PASK: "... we are not predicting **events**, but certain abstract entities called the probabilities of **events** which can be variously interpreted" (1961, p.19).

Moreover *forecast* is widely different from *prediction*, which is obtained in a scientific sense through the application of strictly **deterministic dynamics** laws to some classes of natural **phenomena**, as for example eclipses.

1311

FORECASTING¹⁾

Any rational attempt to predict future **events**.

Forecasting is of course different from divination.

Its results are not, however in many cases much better, because its **methodology** is shaky.

L. DOUGLAS KIEL signals: "The static nature of traditional **linear** and **deterministic models**... provide at best a "snapshot" of reality with, most likely, only **short-term** relevance. The **determinism** generally **embedded** in traditional **linear models** inhibits **dynamics** that may arise over **time**. This can result in naïve **extrapolation** based on **static relationships** between relevant **variables**" (1992, p.35).

This is, for instance, the reason why no high **level decision maker** had any idea that the massive use of insecticides would derive in the **selection** of resistant varieties of pests or even that the appearance of some resistant individuals was a serious problem. Similarly, until AIDS surged, nearly nobody seriously believed that new diseases could suddenly emerge, and still less how and why.

The general cause of this type of problems is that most systems are **nonlinear**, with the result signaled by W.D. GROSSMANN and K.E.F. WATT: "Actual mathematical **chaotic behavior** has indeed been observed since 1976 in most areas of science and in many technological areas. As a consequence it will always be impossible to anticipate everything. It could even be speculated that **unpredictable behavior** of systems might even increase their **viability**" (1992, p.4).

K.DE GREENE proposes an "evolving **system-fields**" **methodology** of forecasting, as opposed to the commonly used "**context-free mechanistic** forecasting" (1991).

He argues that this last **methodology** is obsolete and useless in a world in swift **evolution** and that it leads to "... rather weak and naive" results, of which he gives numerous examples. He states: "... **context-free mechanistic** forecasts often assume an unchanging social **structure**, a continuing preeminence of present kinds of **values** and motivations, and a continuity of the political and economic *status quo*" (Ibid., p.62).

He could even have added ecological status quo.

In his opinion, what we need is a type of "**holistic** forecast (in line with) the concept of **fields within fields** within fields" (p.66), i.e. taking in account differential **trends** at **short**, **medium** and **long term**, whose more or less **periodic** interferences can produce the conditions for considerable and even **catastrophic** quantitative and qualitative **changes** (of which we have seen quite numerous ones during this century).

1312

FORECASTING (Adaptive)¹⁾

St. BEER writes that adaptive forecasting "...is like radar locating **events** in **time** instead of **space**" (1968, p.228)

Forecasts obviously must be permanently revised and adapted, since new **information** frequently becomes available. The usefulness of non-adaptive forecasting dwindles rapidly as **time** goes. This explains why so many apparently well conceived projects end up so wide off the mark.

1313

FORERUNNER SIGNALS¹⁾²⁾⁵⁾

Many unexpected **changes** in **processes** and systems could be predicted, or at least detected with a good **anticipation**, if some specific **events** could be recognized in due **time** as early warnings.

The general problem of **forecasting** is most frequently considered in **terms** of more or less complex **extrapolation** of currently running **trends**, be it at **short**-, **medium**- or **long-term** in some **time scale** adapted to the process under study.

But some changes may be innovative to the point of ending the current trends or introduce some completely new process. The sudden appearance of AIDS in the 1980's or more generally unexpected new kinds of **epidemics** (Marburg or Ebola viruses), or market crashes, or volcanic eruptions are good examples.

In the case of AIDS, for example, the forerunner signal was the abnormal number of Kaposi's sarcomas in California at the beginnings of the 1980's.

However, forerunners signals are discovered only by people able to escape their own routine reactions or even able to react when confronted with some uncommon **events**, or sequences of events.

Nobody can pick up any forerunner **signal** if not aware that some unexpected **situation** could develop. Moreover, forerunner signals are much clearer for trained people than for untrained ones, who even when perceiving some abnormality, are unable to make something out of it.

It is at least partly a matter of **reference frames**.

→ **Change; Cue-Emergence; Forecasting; Power laws; Prospective; Slaving Principle; Term (short, medium, long)**

1314

FORGETTING FACTOR^{2) - 5)}

In markets, the progressive loss of "**memory**" of the system after a period of **time**. (after J. CASTI, 1994, p.106).

This curious feature corresponds to the loss of predictive power that can be obtained from cumulative **data** on the correlative **evolution** of the market. Moreover this factor is different for different stock markets. For example, according to CASTI, its value is 42 months for the NYSE, 36 months in London, 44 months in Tokio and 60 months in Frankfurt. CASTI concludes that: "**chaos** is a major factor influencing price **fluctuations** on the world stock markets" (p.106).

Stock markets and other markets seem to submit to **criticality rules**, which seems to be confirmed by sudden crashes and panics. How and why they lose their "**memory**" remains a good subject for further research.

The forgetting factor could be at work in **living systems**, in **ecosystems** and in **social systems**.

1315

FORM and FORCE^{1) - 3)}

d'ARCY W. THOMPSON wrote (1916): "Form is a diagram of forces". He came to such a conclusion in the following way: "when we abstract our thoughts from the material to its form, or from the thing moved to the motions, when we deal with the *subjective* conceptions of form, or movements, or the movements that **change** of form implies, then Force is the appropriate term for our conception of the causes by which these forms and **changes** are brought about... It is a term as subjective and symbolic as form itself, and so is used appropriately in connection therewith..."

"The form, then, of any portion of **matter**, whether it be living or dead, and the **changes** of form which are apparent in its movements and in its **growth**, may in all cases alike be described as due to the **action** of force" (1916, 1952, p.15-16).

Nowadays the concepts of **energy**, energy **flows** or **energy fields** have more or less replaced the concept of force and we interpret **matter** as local condensations of **energy**. These notions lead us to an interpretation of all systems as a *provisionally permanent* entity condensed within interacting **energy fields** (see "**toroid**", "**vortex**"). Of course, the difference in terminology does not affect THOMPSON's basic views.

A more geometric and static **concept** of form is thus enounced by R. THOM: "Form is always, at long last, a qualitative **discontinuity** referred to some **continuous background**" (1991, p.35).

1316

FORM (Laws of)^{1) - 2)}

"A logical calculus of **distinctions** and **indications**" (K. KRIPPENDORFF, 1986, p.44).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This calculus was developed by G. SPENCER-BROWN (1969). It is basically "an arithmetic whose geometry as yet has no numerical measure: and astonishing as it may seem, the propositions of logic, as well as those of wider and more powerful applications, turn out to be wholly derivable from calculi so constructed" (p. XI).

The real scope of this calculus is still unclear, but SPENCER-BROWN seems to have done for logic in general what G. BOOLE did for binary logic, i.e. give it its general axiomatics and codification.

The first significant derivation of this calculus has been giving a firm formal basis to **self-reference**. This was done by F.A. VARELA (1975). Somewhat later J.A. GOGUEN and F.A. VARELA, applied the **concepts** of **distinction**, **duality** and **complementarity** to systems (1979).

The subject demands a serious study of SPENCER-BROWN's own work.

1317

FORMAL SYSTEM MODEL ²⁾³⁾

"A generalized model of any **human activity system** from the point of view of: taking purposeful **action** in pursuit of a **purpose**" (R. RODRIGUEZ ULLOA, Glossary, 1999).

"It may be used to test the basic adequacy of **conceptual models**" (Ibid)

Of course, all models, including the **human activity system model**, "are intellectual **constructs**... for use in a debate about possible **changes** which might be introduced into a real-world **problem situation**" (Ibid).

Intellectual **constructs** should however be submitted to a rigorous mental technique of the kind proposed by J. WARFIELD, for instance, including the use of **situation complexity indexes**, **subsumptive transformations**, **nominal group technique**, and avoiding **underconceptualization** introduced by **clanthink** and **groupthink**.

1318

FORMALISM (Experimental) ²⁾

The possibility to extract useful formalisms from experiments or statistical inquiries.

After the establishment of some formalisms, it becomes possible to validate it (or refute) through new experiments. This is thus a methodological round-trip.

1319

FOUNDERS EFFECT ^{1) - 4)}

The **long-term dominance** in a system of the characteristics brought into it by its founders.

Such characteristics can be genetic, in **populations**; phonetic, semiotic and **semantic** in **languages**; technical, normative and cultural in societies.

It has been well observed on more or less isolated **populations** of recent historical origins, as for example French Canadians, white South Africans of Dutch stock, or the Kel Kummer succeeded Touareg **group** (A. CHAVENTRÉ and A. JACQUARD, 1974, p.179-93).

Founders have an influence quite disproportionate to their original numbers. They are generally able to transmit their specific and peculiar traits to their descendants.

In a sense, the founders effect is already present in **embryogenesis**. The egg develops along different lines of "founding **cells**" which generate the different **parts** of the embryo" (Eric H. DAVIDSON & al., 1997). According to these authors, no **hierarchical regulation** is needed - or very few anyway - nor a **process** of local specification. It thus seems to be ordering through reciprocal position, creating a **positional value**.

The complete developmental **process**, specially in bilateral living beings is of course much more intricate, as the Hox genes act as **regulators** of the **hierarchic morphogenesis** which determines the ordered plan of the being as a whole.

→ **Homeobox; Morphospace**

1320

FOURIER ANALYSIS ^{2) - 5)}

A mathematical technique created by the French mathematician Jean-Baptiste FOURIER that permits to decompose any continuous **signal** through a combination of various sine **waves**.

A FOURIER series is a sum of terms each with a defined **amplitude** and **frequency**, i.e. a sum of different sine **waves**.

This may lead to arbitrary **representations** as well as to a more or less adequate **model** of some complex **process** through the **cyclical** interferences of sine **waves** that may - or may not - correspond to different interconnected **periodicities**.

This method is also known as "**Frequency analysis**", "**Harmonic analysis**" or "**Spectral analysis**"

K. BOULDING however made the following ironic comment: "... **spectral analysis** (which) is an elegant way of detecting probably non-existent **cycles** and throws no light on the real **structures** and **processes** which underlie **fluctuations**" (1972, p.70).

Indeed, as stated by D. BOHM and F.D. PEAT: "By means of FOURIER analysis, a particular arbitrary form can be built out of **sets** of periodic **waves**, each of which is of a global **order**".

... and: "While each simple **wave** represents a **global order**, when they are put together they add up to produce a complex **local order** as well" (1987, p.161-2).

The problem is that either that global or local **order** is very difficult to explain, or that the given explanation may be baseless. Anyhow, as observed by M. TALBOT, FOURIER transforms are the mathematical analogue of a hologram (1991, p.27).

Unfortunately, due to the resulting controversies about **cycles** and pseudo-**cycles**: "... economists seem virtually to have lost interest in the theory of **fluctuations**" (BOULDING, 1972, 4, p.70).

The subject deserves to be reconsidered, possibly using the **WEIERSTRASS renormalization**, the **deterministic chaos models** and the renewal in **cycles** studies started by K.DE GREENE.

1321

FRACTAL ^{2) - 5)}

A figure that is **self-similar** at different **scales**.

The conceptual base of fractals is **recursive self-similarity** by **scaling**.

Fractals involve **similarities** generated by a **template**, independent of changes of **scales**. They are also characterized by the absence of derivative, an infinity of details, an infinite length and a fractional **dimension**.

The mathematical theory was established by B. MANDELBROT (1983), but numerous fractal figures were described beforehand by various authors, who did not seem to have perceived their common ground:

- LICHTENBERG's figures (18th. century!)
- KOCH's snow flakes and curves
- SIERPINSKI's carpets
- Menger's sponges
- PEANO's curves
- CANTOR's triadic sets

The **WEIERSTRASS function** is also **self-similar** and may lead to fractalized **representations of processes**.

Recently, A. EDWARDS fractalized the VENN diagrams, a very interesting and useful application, for taxonomic uses (1979, p.51-56).

Fractals describe **structures** and are somehow static **objects**, if one is not interested in the order of appearance of their **components** at successive **self-similar levels**.

Fractals are increasingly used to modelize a number of natural **processes**. A recent example is their application to the study of **epidemics** (Ph. Sabatier et al., 1998)

There seems also to be a relation between fractals and **percolation**

1322

FRACTAL AGGREGATION ^{2) - 5)}

T. WITTEN and L.M. SANDER described this method of **clustering elements** in a **fractal** way (as quoted by I. STEWART, 1992): "They started with a single "seed" particle, and created a growing **cluster** by allowing tiny circular particles to attach themselves one at a time.

Successive new particles moved towards the **cluster** in a "random walk", a series of **random** motions in all directions... Wherever the particles hit, they stuck. This **process**, which is known as **diffusion limited aggregation**, or DIA, leads to delicate branching **structures**. Very similar **forms** are seen in nature: not only in soot, but also in the electrodeposition of metals and the **growth** of colonies of bacteria" (p.14).

H. SABELLI observes that the repetition of a simple fractal **structure** allows for the construction of complex and irregular **structures**, starting from a minimal genetic **message**. (pers. comm.)

1323

FRACTAL BASIN BOUNDARIES ²⁾ - 5)

Fractal basin boundaries are **discontinuous** and practically impossible to precisely pin down. They tend to dissolve into a growingly scattered "dust" of points and the **transition** of the system from one type of **equilibrium** to another cannot be properly predicted.

However, by observing, for example, the **WEIERSTRASS function**, it becomes clear that, at any **level**, **thresholds** of **instability** can be defined, at least tentatively, even if no **prediction's** validity can be taken for unquestionably secure.

The relative positions of the **instability thresholds** corresponding to various **levels** must be considered, since it is important in order to emphasize the normal or extreme character of a **situation**.

1324

FRACTAL COMPRESSION

The use of fractals to reduce the volume of **information** that must be treated.

Fractals can be used in this manner because they are **self-referential**: recurring **patterns** appear at different **scales**. Thus, when **information** is distributed at different **levels**, as for example in **images** in video recording systems, the recurring pattern must be stored only once i.e. not repeated in a **redundant** way- and called for use only when necessary at some **scale** or other. (Economist, Apr. 13, 1996, p. 91)

→ **Algorithms (Genetic); Self similarity;- Morphogenetic fields; Randomness (constrained); Search (Random)**

1325

FRACTAL CURVES, SURFACES AND VOLUMES ³⁾ - 5)

The concept of fractalization is now unifying and making clearer a number of geometrical paradoxes which appeared since the end of the 19th Century. All had a common feature: the **emergence** of fractionary dimensions.

1. The CANTOR set: The removal of the central third of a segment, and the reiteration of the same operation on the remaining **parts** produced a **set** of infinitely many points, but their total length at infinity is zero.

2. The von KOCH curve: In this case, starting with an equilateral triangle, constructing on the central third of each side a new equilateral triangle and iterating this **process**, an apparently infinitely long perimeter surrounds a finite area.

3. The SIERPINSKI carpet: "is constructed by cutting the center one-ninth of a square; then cutting out the centers of the eight smaller squares, and so on" (J. GLEICK, 1987, p.101). The **limit**, which would imply the complete disappearance of the carpet can obviously never be reached.

4. The Menger sponge: "is the three dimensional analogue (of the SIERPINSKI carpet)... a solid lattice that has an infinite surface area, and yet zero volume" (p.101).

While these **constructs** are abstract, they are nonetheless extremely useful to understand natural **structures** as diverse as a rocky or sandy coast, the branching of trees and the construction of leaves, the enormous surface of the human lungs, the **Brownian motion** of molecules and, possibly, the **distribution** of galaxies in the cosmos. From an epistemological viewpoint, one should however be aware of the paradoxes of infinity... which are actually as old of Zenon and his arrow.

1326

FRACTAL DIMENSIONS ⁵⁾

A curious consequence of fractalization is the appearance of fractal dimensions, i.e. fractional ones.

The dimension of the PEANO's curve, for example is neither 1, nor 0: it is intermediate, as the one-dimensional line slowly disappears, but leaves a growing number of still related, but not anymore connected points.

Fractal dimensions appear also in natural features.

The fractal dimension of the Norwegian coast, for example, has been calculated as 1,52

1327

FRACTAL GEOMETRY ²⁾

"(A geometry) which models the recurrence of **similar patterns** at different **scales** which characterizes most natural systems" (F. HEYLIGHEN, 1997, p.33)

Fractal geometry was introduced by the French mathematician Benoit MANDELBROT (1983).

HEYLIGHEN comments: "Such **self-similar structures** exhibit **power laws**, like the famous **ZIPF Law** governing the **frequency** of words. By studying **processes** such as **avalanches** and earthquakes, Per BAK (1988,

1991, 1996) showed that many complex systems will evolve spontaneously toward the **critical edge** between **order (stability)** and **chaos**, where the **size** of **disturbances** obeys a **power law**, larger **distributions** being less frequent than smaller ones. He calls this **phenomenon self-organized criticality**" (Ibid).

1328

FRACTAL PROCESS ⁵⁾

"A process that cannot be characterized by a single scale of **time** (a single **frequency**)" (B.J WEST & A.L. GOLDBERGER, 1987, p.364).

To make this clearer it should be added that there is a superposition of **embedded frequencies** at different **levels**. See "**self-similarity**" and **WEIERSTRASS function**.

1329

FRACTAL SCALING ⁵⁾

A process that leads to the development of **self-similar structures** at different **levels**.

This **process** is a very general one and has been recognized in a great **variety** of natural **phenomena**, e.g. numerous biological **structures** in vegetals and animals; of the snowflakes; of coastlines, etc. Fractal scaling has been easily mimicked on computers and could readily be related to some formerly enigmatic topological **forms** (**Fractal curves, surfaces and volumes**), as well as to the "**WEIERSTRASS function**".

1330

FRACTAL TIME ²⁾ - 5)

As **fractal processes** operate through **embedded self-similar** and superposed **frequencies** they necessarily operate within embedded **scales** of **time**.

This can easily be understood by looking at the graphic representation of a **WEIERSTRASS function**.

1331

FRACTIONATION ²⁾ - 3) - 4)

The break-up of a system "into a spectrum of simpler **subsystems**" (R. ROSEN, 1972, p.53).

This term is used by ROSEN, in correspondence with the **reductionist** methodology. He rightly states: "Implicit in this are two crucial hypothesis, of a system-theoric character: namely, that any physicochemical system, however complex, can be resolved into a spectrum of fractions such that a) each of the fractions, in isolation, is capable of being completely understood, and, most important, that b) any property of the original system can be reconstructed from the relevant properties of the fractional **subsystems**. This last hypothesis is demonstrably false for many systems, including

most of those of biological interest. A simple physical counterexample is a system of three gravitating masses in **space** (**three-body problem**)" (Ibid).

Since ROSEN wrote these lines, new complex **models** (**Catastrophes**, **hypercycles**, **deterministic chaos**), better adapted to the global study of complex systems, have appeared.

1332

FRAGMENTATION ^{1) - 2) - 4)}

The **breakdown** of a system into various separated **parts**.

The original **concept** comes from A. TOYNBEE, who applied it to the final destruction of empires, which he attributed to the loss of some critical monopolies.

Fragmentation seems however to be a quite general **phenomenon** related to some types of systems widely extended in **space**, as **populations** or species. It seems to be mostly determined by the severance of **communication** lines, which in turn is generally a result of their overextension and the existence of very different conditions in distant **parts** of the system.

Fragmentation can also be considered as inverse or complementary to the **process** of **percolation**.

For example, a result of general ecological **transformation** of **ecosystems** by man is their progressive splitting into impoverished, ill-connected or disconnected **patches**. Extreme fragmentation may lead to the reduction and even total destruction of some types of **elements**, as they become unable to reproduce and propagate in the fragmented setting.

The same process occurs in archaic societies under the pressure of invaders or colonists.

1333

FRAGMENTATION PROBLEM ³⁾

"Is nature in itself fragmentable, and thereby non-distortively describable, or is it our linguistic **description process** which makes nature appear fragmentable?" (L. LÖFGREN, 2000, p. 15)

This ontological class riddle is obviously insoluble. In any case we generally approach **phenomena** in a fragmented way (as good conceptual descendants of Descartes). And, of course, fragmentation severs **links**, and also partly disgregates our **understanding**.

1334

FRAME ³⁾

A global **representation** of a more or less extended **class** of **objects** or **concepts**.

M. BODEN states: "Frames, as defined in **AI**, are **hierarchical**, for they can include lower-level frames – as 'vertebrate' includes 'bird' and 'house' includes 'room'. Various **slots** are defined within the frame, and specific instances of the general **class** in question are repre-

sented by having different details in the (low-level) slots in the frame. A **programmed** frame will include suggestions for moving around within the relevant part of **conceptual space**" (1990, p.99).

Current **AI** frames are to date more limited than human mental frames.

→ **Reference** (**Frame of**)

1335

FRAME (Mental) ^{2) - 3) - 4)}

A particular mental **model**, which has multiple **components**.

As a basis for his **Global Design and Interpretive Structural Modeling methodologies** J. WARFIELD describes these **components**: "Among the **components**... may be a **model** that defines the **boundaries** and **dimensions** of a **situation** (a "**context**" **model**), a **model** representing the organized **information** about that **situation** (the "**content**" **model**) and a **model** representing a proposed way of changing that **situation** (a "**process**" **model**) These **components** may be implicit or explicit, but they are loosely integrated into a framework" (1989, p.27).

→ **Reference frame**

1336

FRAMEBREAKING ^{2) - 3) - 4)}

The giving up of **part** or the **whole** of a **mental frame**.

Framebreaking is, in many cases, a necessary first step for any **process** of **transformation**. It needs preceed **frame remodeling**, i.e. the development of a new and better adapted way of thinking.

J. WARFIELD writes: "Framebreaking presumes the development of awareness followed by the recognition that some existing way of thinking about a **situation** is not adequate to reform that **situation**. It further presumes a motivation to change the **situation** and the latent capacity to do so" (1989, p.26).

This is a typical systemic way to take distance from one's own prejudices. "It implies at least a willingness to give up old **frames** of thought in order to rethink a field" (WARFIELD, 1990a, p.69).

1337

FRANKFURT SCHOOL ¹⁾

A group of German philosophers and sociologists who took up "Marx's highly political exemplar of critical theory" and reformulated it "into a research program at the Frankfurt Institute for Social Research which began its work in the 1920's. The three main contributors to the early work of the "Frankfurt school" were HORKHEIMER, ADORNO and MARCUSE"(M. JACKSON, 2000, p. 30-31)

I. CRAIB, as quoted by Jackson states: "...the Frankfurt theorists are concerned with the way the system dominates: with the ways in which it forces, manipulates, blinds or fools people into ensuring its **reproduction** and continuation"(Ibid)

After the nazi period and WWII, the Frankfurt School resumed its activities, and its work was continued by the German philosopher Jürgen HABERMAS. It started to gather a growing influence, particularly in France with P. BOURDIEU (1989, 2000, 2001) M. FOUCAULT, J.F. LYOTARD, F. DERRIDA, and others.

M. Jackson offers a quite interesting panorama about the influence of the Frankfurt School in contemporary social theory, even if its work cannot be plainly identified as systemic (2000, p. 30-42)

He observes anyhow that the latest phase to date of german social thought "is found in LUHMANN's highly technocratic, all-embracing and despairing version of **systems theory**. In this, instrumental reason is completely triumphant as everything is subject to the rational requirements of the societal system".

And "Humanity is dragged in the wake of the system"(Ibid, p. 36). A comparison with insect societies seems rather ominous.

→ **Sociality; Stigmergy; Swarm intelligence**

1338

FREEDOM (Constrained) ¹⁾

The limitation to the **degrees of freedom** in a system.

Any **function** in a system must be by necessity maintained within **limits**, for at least two interrelated reasons:

- Any **runaway process** affecting a systemic **function** would quickly endanger the **survival** of the system as a **whole** in the **environment** on which it depends for its **input resources** or for its **output** absorption
- Any such **disequilibrium** in one **function** would quickly lead to dangerous **disturbances** in other **functions**.

→ **General adaptation syndrome; Strain; Stress**

1339

FREE-WILL: A tentative systemic view ¹⁾³⁾

It could be said that the systems **worldview** (or **Weltanschauung**) clarifies somewhat the conditions in which free will could be discussed.

In systemic terms, free-will seems to be a quite constrained possibility, within at least the following conditions:

- Physiological **limits** of various kinds, with finally the enormous, but also limited capacity of the human **brain** to form **concepts** and **values** leading to a considerable **domain** of possible **behaviors**

- **Socio-cultural limits** under the guise of submission to socially accepted values and **norms** whose infringements are severely punished

The possibility of sudden **emergence** of some innovative way of **understanding**, leading eventually to an innovative behavior, introduces still other question marks

On the other hand, free-will corresponds to a **decision** taken by a (supposedly) rational **agent**, at a specific present moment

This is closely connected to the concept of **autonomy** in VENDRYES' sense, i.e. "the capacity of a system to select and decide, within **limits**, its own behavior".

This is done at any moment by selecting one behavior among many possible ones, that become automatically suppressed by the very **act of decision**.

→ **Bayesian probability; Choice; Decision making; Emergence; Nucleation**

1340

FREEZING EFFECT ¹⁾²⁾

A near synonym for "**Jamming transition**".

M. BUCHANAN observes, in relation to traffic jams: "At (some) point, the cars and lorries begin to roll down the road in a solid mass, like molecules locked in a crystal" (2000, p.31).

Freezing effects seem thus to lead to KAUFFMAN's **frozen cores**. A better connexion between both **models** should be considered.

1341

FREQUENCY ⁵⁾

The number of **oscillations** per unit of **time** in a periodic **phenomenon**

In complex **nonlinear systems**, the presence of various simultaneous **processes** accounts for the existence of superimposed periodic **phenomena** and a globally mixed up behavioral curve, wherein the specific frequencies corresponding to the different **processes** are **embedded**.

In these cases, the global aspect of the **process** frequencies appears as irregular.

Complex curves can be studied through **frequency** (or harmonic, or **spectral**, or **FOURIER**) **analysis**, but their decomposition is based either on pre-determined hypotheses, or on pure mathematical technique and, as such, the results are sometimes questionable.

Incommensurability of merely three frequencies in a **nonlinear dynamic system** is a basic factor for the onset of **chaotic behavior**.

1342

FREQUENCY ANALYSIS ⁵⁾

(also known as **FOURIER analysis**, or **FOURIER transform** and **spectral analysis**).

"In theory, any waveform can be described as the sum of sine **waves**, but in practice, the **method** becomes infinitely cumbersome for impulse type **functions**". Moreover: "The **language** of frequency analysis has a "**blind spot**" for the **concept** of "sudden **change**" (i.e., **discontinuous**) (D. Mac KAY, 1969, p.113).

1343

FREQUENCY DOMAIN ²⁾

"A mode of discussion where **events** are not seen as occurring at points in **time**, but rather according to the frequency of their recurrence" (T.F.H. ALLEN and T.B. STARR, 1982, p.268).

1344

FREQUENCY MODULATION ⁵⁾

"A mode of **communication** in which... **signals** are transmitted by varying the number of pulses of a carrier **wave**" (Adapted from J.Z. YOUNG, 1978, p.293).

1345

FROG (Parable of the boiled) ^{1) - 4)}

A parable aimed at showing the danger of unperceived slight, but accumulative **long-term transformations**.

A frog put in lukewarm water very progressively heated, adapts to the slowly increasing heat, until it is too late for escape and becomes boiled.

One wonders if a number of present slow, **long term** and not very perceptible **transformations**, mainly in **ecosystems**, are not equivalent for humankind to the boiled frog **process**.

1346

FROG's EYE EXPERIMENT ^{2) - 3)}

"What the frog's eye tells to the frog's brain" was the title of a seminal and now classical paper presented by J.Y. LETTVIN, H.R. MATURANA, W.S. Mc CULLOCH and W. H. PITTS in 1959. (Proceedings of the IRE, 47, 11, 1959)

These authors showed that the **information** transmitted to the brain is not merely "... a mosaic of light which maps **images** focused on the retina in some sort of geometric **pattern** in the **brain**" (anonymous reviewer in Behavioral Science - Vol 5, nr.3, 1960).

On the contrary: "... the nervous apparatus of the eye itself is designed to detect certain **patterns** of light and... the optic fibers transmit only certain operational **information** about these **patterns** to the **brain**... The conclusions reached were that four separate **operations** are performed on the **image** of the frog's eye and that the result of each of these **operations** is transmitted by a separate group of fibers, uniformly distributed across the retina. The four **operations** are:

1. sustained contrast detection

2. net convexity detection

3. moving edge detection

4. net dimming detection" (Ibid)

Some general conclusions seem unavoidable, covering human sight altogether:

- Visual **perception** is not merely the passive registration of **environmental light flows**.

- **Perception** is highly selective.

- This **selectivity** is based on genetically inherited physico-physiological perceptive devices (which by the way explains, for instance, why different animals have different **ranges** of color **perception**).

- The **brain** reconstructs its own perceptive synthesis in its own way.

- Once learned, perceptive ways become more or less fixed in an **algorithmic** form (see **HEBB's rule**), which is also possibly why and how we form MARIYAMA's **mindscape**s.

As a general consequence, the **observer** is inextricably enmeshed as an active participant of what he/she observes, and so-called **objectivity** must be seriously relativized.

As also noted by J.L. SNELL and W.S. McCULLOCH "... given certain assumptions, **neural networks** could embody logic, **pattern recognition**, **learning**, **purpose** and other mental faculties" (1988, p.360).

Finally, the frog's eye experiment started MATURANA on his way toward the **autopoiesis concept** and its **organizational closure** complement.

1347

FROZEN CORE ²⁾

"A connected mesh of **elements**, each frozen in either the 1 or the 0 **state**" (St. KAUFFMAN, 1993, p.203).

St. KAUFFMAN describes frozen cores as follows: "The frozen core creates spanning, or **percolating** walls of constancy which break the system into functionally isolated islands of unfrozen **elements** cut off from influencing one another by the walls of frozen **elements**" (1993, p.203).

He adds: "Systems may lie in the ordered **regime** with frozen **components**, in the **chaotic** regime with no frozen **components**, or in the **boundary region** between **order** and **chaos** where frozen **components** just melt. The existence of this **phase transition** suggests that the **boundary region** might be a particularly interesting **region** for useful **behavior** in complex **parallel-processing networks**... The central idea is that, if a **network** is deep in the frozen **phase**, then little computation can occur within it. At best, each small unfrozen, isolated island engages in its own internal **dynamics** functionally uncoupled from the rest of the system by the frozen **component**. In the **chaotic phase**, **dynamics** is too disordered to be useful... At the **boundary** between **order** and **chaos**, the frozen **regime** is melting and the functionally isolated unfrozen islands are in tenuous shifting

contact with one another. It seems plausible that the most complex, most integrated, and most evolvable **behavior** might occur in this **boundary region**" (p.219).

As a resulting hypothesis, KAUFFMAN proposes that "**Ecosystems coevolve** to the edge of **chaos**" (p.261).

These views are closely connected with PRIGOGINE's: See hereafter: "**Frozen structure**".

see figure right

1348

FROZEN STATE²⁾

The state of a **part** of a system that becomes permanent.

A frozen state reflects stable **constraints** imposed upon that **part** of the system.

1349

FROZEN STRUCTURE²⁾

A structure that becomes permanent once it emerged.

Frozen structures are a result of **dissipative structuration** in **systems far-from-equilibrium**. They are characterized by a **content** and enclosed into a **boundary**.

I. PRIGOGINE describes the **process** leading to frozen structures: "If the appearance of a certain **sequence** involves overcoming a barrier, then the peculiar conditions at the appropriate **time** will create a particular **sequence** that will then dominate and become permanent" (1984, p.55).

One of the examples given by this author is "The spontaneous appearance of certain sequences of RNA, depending on the **environmental** conditions, (that) has been investigated and experimentally demonstrated by Manfred EIGEN" (Ibid).

→ "Game of Life"

1350

FUNCTION¹⁾

A relation between two terms (E. SCHWARZ, 1993,p.6)

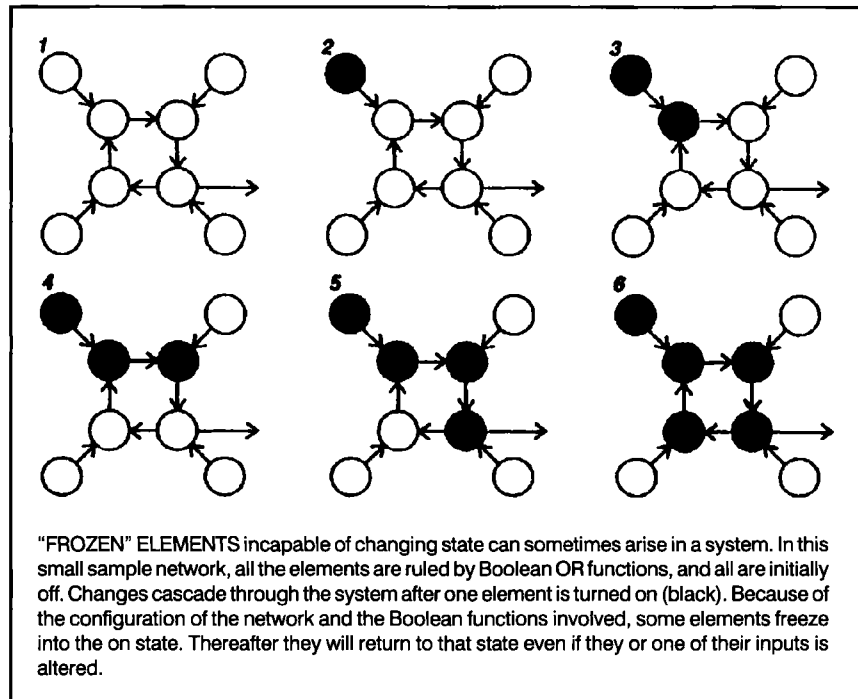
More generally, any function implies a more or less permanent causal **relationship** exerted by some **element** on another element.

This correspond to a **process** – generally **iterative** – that must be carried out to maintain the system's **stability**, its **goal(s)** or general **purpose**, or even, its existence.

The concept of function is closely related to various other ones:

- The **iteration** of a functional **process** evokes the appearance of **sets of elements** permanently interrelated in a specific fashion, namely a **structure**.
- Functional **processes** must be harmonized with each other in the system if it is to maintain itself globally, i.e. as an organized

Figure: see entry FROZEN CORE



From St. Kauffman: 1991, p. 67

whole. They must remain within the **limits** of the **organizational closure** specific of the system.

- Functional **processes** are most generally **cyclical** (i.e., in **homeostatic** systems) and maintain some **critical values** between defined upper and lower **limits**. This is generally obtained through alternating **positive** and **negative** feedbacks.
- Functional processes are frequently interconnected in a circular way, i.e., included in **hypercycles**. A **process** may be **internally** hypercyclical.
- An excessive **stress** endured by a system's function may progressively bear upon other functions and lead to general disabling of the system. See: "**General Adaptation Syndrome**".

In a different perspective, more related to **far-from-equilibrium situations** in systems, I. PRIGOGINE considers that: "**Dissipative structures...** form a bridge between function and **structure**" (1976, p.95). The shaping of new functions and new **structures** are concomitant **phenomena**.

1351

FUNCTION (Canalizing)²⁾

"A **Boolean** switching rule (such as) at least one **input** has a **value** that can by itself determine the **activity** of the regulated **element**" (St. KAUFFMAN, 1991, p.69).

"The **OR** function is a typical canalizing function" (Ibid). According to KAUFFMAN: "Like low **connectivity** or biases in the **Boolean**

rules, an abundance of canalizing functions in a **network** can create an extensive **frozen core**. Increasing the proportion of canalizing functions used in a **network** can therefore drive the system toward a **phase transition** between **chaos** and **order**" (Ibid).

Here **chaos** should possibly be understood as **primeval chaos**, when a system starts its **self organization process**. In **complex systems**, **deterministic chaos** and **order** seem to be the two faces of the same global **behavior**.

1352

FUNCTION CHANGE (Principle of)^{1) - 2)}

The potential in unused **degrees of freedom** to create innovative **functions**.

This principle has been stated and explained by R. ROSEN (1979, p.63), who gives the following example: "Many fishes possess swim bladders, a bag or tissue filled with air, as an organ of **equilibration**. Being a bag of tissue, the swim bladder is vascularized (possesses blood vessels). When air and small blood vessels are in contact, there will necessarily be gas exchange between the blood and the air, and so a respiratory function is incipient in this **structure**".

According to ROSEN: "This Principle of Function Change is thus one of the cornerstones of **evolution** (and indeed of any kind of adaptive **behavior**), and it depends essentially on the fact that the same **structure** is capable of simultaneously manifesting a **variety** of functions" (Ibid).

Function change can be enhanced by increased **variety**, which brings about new **degrees of freedom** – sometimes implicit – and may lead to more **complexity**.

1353

FUNCTION CONSTRUCTION ^{1) – 2) – 4)}

The synthesis of a higher **level** function through **interactions** between elemental units.

J. ERCEAU AND J. FERBER explain that "... elementary units show specific **behaviors** that do not necessarily coincide with subfunctions of the desired function. This latter will emerge from **interactions** between elementary units" (see **eco-behavior**), and, expressing that this is a **bottom-up** approach... "The system does organize itself in order to react adequately in every case, which makes it flexible. Moreover a **breakdown** of one unit does not impair the global working of the **whole**, which makes the system robust" (1991, p.755).

While the authors thus describe a property of **distributed artificial intelligence** systems, the similarity with complex social functions in human **groups** and societies is striking.

1354

FUNCTION (Distributed) ^{1) – 2)}

A function that may eventually be fulfilled by different groups of **elements** within a **complex system**.

In **complex systems** (a species, a **brain**, a society) numerous **groups** of **elements** more or less independent from each others, even when interconnected, are potentially able to fulfill the same function.

Thanks to such a **mode of organization**, the destruction of some **group of elements** does not imply, at least in some cases, the elimination of the function that they fulfilled. After a time another **group** form, able to insert itself into the global **organization** in a new way, and fulfill totally or partially the function.

Distributed functions implies **redundancy** in the system.

1355

FUNCTION (Hidden) ¹⁾

A **function** that cannot easily be discovered and evaluated.

Complex systems may have such hidden functions, corresponding to slow or minimal **processes**. Many recently discovered biological and physiological **regulations** are of this type. Other **regulations**, that act at long or very **long term** also are difficult to discover. Plate tectonics as a geological mechanism has been an example.

In **human systems**, the role of **values**, **norms** and **mindscapes** is still widely undervalued or misunderstood, or even downright ignored, while they may produce unforeseen and sometimes violent and critical **effects**.

1356

FUNCTION (Part-) ²⁾

An **activity** of a system or in an **environment** characterized by **variables** that remain constant over appreciable intervals of **time**. (after W.R. ASHBY, 1960, p.193).

ASHBY comments: "If one looks around one, only in the most **chaotic** surroundings will all the **variables** be changing"... and "...the **environment** of the living **organisms** tends typically to consist of **parts** that are rich in **states of equilibrium**" (Ibid).

Part-functions correspond to acquired **constraints** in the system and to **behaviors** created by **learning** or **training**, in correspondence with the main part-functions in the **environment**.

1357

FUNCTION (Specific) ¹⁾³⁾

The **set of processes** that are exclusive characteristics of some type of **components** in a **concrete system** (adapted from M. BUNGE, 1995, p.34).

BUNGE adds: "This **concept** is necessary... in order not to ascribe any **finality** to things as **cells**, plants, businesses or governments - that cannot conceive **finalities** because they do not have frontal lobes" (Ibid).

1358

FUNCTION (Step) ²⁾

"A function which "has finite intervals of **constancy** separated by instantaneous jumps" (W.R. ASHBY, 1960, p.87).

ASHBY gives some interesting examples:

"1. The electric switch has an electrical resistance which remains constant except when it changes by a sudden jump.

...

"3. If a piece of rubber is stretched, the pull it exerts is approximately proportional to its length. The constant of proportionality has a definite constant **value** unless the elastic is stretched so far that it breaks. When this happens the constant of proportionality suddenly becomes zero, i.e. it changes as a step function.

...

"7. By quantum principles, many atomic and molecular **variables** change in step-function form" (p.89).

ASHBY concludes: "Any **variable** which acts only in "all-or-none" degree shows this form of **behavior** if each degree is sustained over a finite interval" (p.89).

This should be compared with THOM's elemental **catastrophes**.

However, as ASHBY himself points out, "...whether a **variable** of a real **object** behaves as a step-function cannot in general be decided until the details of the **method of observation** are specified" (p.90).

In other words, a **variable** may appear as varying continuously or step-wise according to the **observation scale**.

According to E.von GLASERSFELD, the step function corresponds to "... the unstable **transition** between two **stable regions** given the name of **catastrophe** by THOM. These appear to be reminiscent of the **description** of a **step change** function in ASHBY's **homeostat** and may represent for us the accomplishment of the all-important step function required by ASHBY for his **model** of a **machine** that was both **stable** and capable of **learning**" (1976, p.123).

1359

FUNCTION (The four basic types of constancy in a) ²⁾

W.R. ASHBY distinguishes four basic types of functions from the viewpoint of the extent to which a **variable** displays constancy, namely:

"A. The full-function has no finite interval of **constancy**; many common physical **variables** are of this type: the height of the barometer, for instance;

"B. The **part-function** has finite intervals of **change** and finite intervals of **constancy**;

"C. The **step-function** has finite intervals of **constancy** separated by instantaneous jumps → ("**step function**")

"D. The **null-function** which shows no **change** over the whole **period of observation**.

"The four types obviously include all the possibilities, except for mixed forms" (1960, p.87).

1360

FUNCTION (Transference) ²⁾

A function that describes the relation between an excitation **stimulus** applied to a **mechanism** and the corresponding **response** (After L. BAYLISS, 1966).

BAYLISS applies this notion to biological systems, but its scope is clearly much more general.

1361

FUNCTIONAL COMPARTMENT ²⁾⁴⁾

A **region** in a not clearly structured system where some **elements** of a specific type work together.

This notion has been proposed by M. HOPPERT and F. MEYER (1999, p.518). They give as an example the grouping in a specific area in a prokaryote cell of "the molecules required for a particular **metabolic activity**".

This would be a stage preliminary to the appearance of **membrane**-bounded compartments in the eukaryotes.

The authors add: "Studies... suggest that functional compartments arise spontaneously as a result of the intrinsic properties of the biomolecules themselves and the way they inter-

act with water in the cytoplasm. We have also found that the specific **structure** of water itself can influence the **level** of enzyme **activity** in particular microenvironments".

These **phenomena** seem to be good examples of CSANYI's **autogenesis**, **autogenetic systems precursors** and **zero-systems**.

Functional compartments could probably be used as **models** for the progressive appearance and upbuilding of new **structures** in human societies, specially during the present planetary **globalization process**.

1362

FUNCTIONALISM ¹⁾ – 3) – 4)

The main characteristic of any theory aiming at explaining a system's **behavior** in terms of usefulness, **purpose** or practicality.

R. SNOW writes: "Functionalists view any system in terms of the "job" it was created to do: its **purpose** or **function**" (1993, p.137).

She adds: "A simple example from elementary **communications theory** illustrates the functionalist point of view. Any **communication** system exists for the **purpose** of transmitting **information** from a sender to a receiver. This is its **function**, the essential property that defines it as a system. The sender, receiver, as well as the **information** that passes between them are all **parts** of the system's **structure**. This **structure** is subordinate to the **function** in two ways: 1) it does not serve to define the system and 2) it can be altered significantly – in some cases changed completely – without altering the system's **identity**. So, from the functionalist perspective, a **communication** system would still exist if one sender was replaced by two, or the **information** passed by means of satellite, telephone or shouting" (Ibid).

Functionalism is very close to **1st cybernetics**, as noted by SNOW, who observes moreover that "... **machine images** do pervade much of this (**cybernetic**) literature" (p.141).

Also: "Functionalist theory is replete with **binary** oppositions and logical typing via **categories**" (p.143).

M.C. JACKSON observes that, in the case of **human systems** or **organizations**, functionalists "... study systems from the outside, seek causal regularities, believed that human beings can be understood scientifically and then dealt with as **component parts** of the system, and prefer quantitative techniques of analysis" (1992, p.70).

This **mechanicist** (and **first cybernetic**) view leads easily to manipulation in **human systems**: any "**component**", human or **artifact**, can always be replaced by any other one, similar in functional terms... and there is no more to it than just that. Of course, in such set-

ting, individuals do not positively collaborate; they merely... function.

Within **systemic concepts** and **models**, functionalism offers merely specific ways to **model** some rather limited aspects of systems **behavior**.

1363

FUNCTIONS (basic) of a system (in Systems Dynamics) ⁵⁾

J.de ROSNAY, thus resumes the basic concepts of functions in FORRESTER's **Systems Dynamics**:

"The basic functions of any system are as follows:

"**Flow** (of **energy**, **information** or **elements** are moving from **stores** to **stores**. These **flows** are meted in quantity per **time** unit (figuring **outputs**)... as for example: money **flows** (wages...per month), ...products (cars produced per day)...or people (travellers per hour), or **information** (**bits**... per micro second in a computer).

"**Energy** and **matter's flows** rise or lower the **levels** in the **stores**. They move through **communication channels** and are represented by thick black arrows.

"The **information flows** are represented by dotted arrows. The **informations** are the base for **decisions** which allow for **action** on the **flows**, in order to maintain, increase or lower **levels** in the **stores**.

"**Gates** (or **rates**)... control the turnover of the different **flows**. Each **gate** may be seen as a **decision** center receiving **informations** and transforming them in **actions**: for example a manager, an institution, some **transformation agent** or an enzyme as catalyser.

Such **actions** result in an increase or decrease of the **flows** intensity.

Their symbolic **representation** is a **gate** or tap on a **flow** line.

"**Delays** result of the different velocities of circulation of the **flows**, of storing **periods** in the **stores**, or of frictions between the **elements** of the system. **Delays** play a very important **role** in the **amplification** or inhibition **phenomena**, which are typical of the **complex systems**.

"Finally, there are **information loops**, called **feedbacks**. They play a determining **role** in the systems **behavior** by combining the **effects** of stores (**levels**), **delays**, **gates** and **flows**.

"There are two types of **feedbacks**: **positive** and **negative feedbacks**. The whole **dynamics** of **change** in a system (**Growth** and **evolution** for example) depend on **positive feedback**. **Regulation** and **stability** depend on **negative feedback** (Restoring of **equilibria** and **self-maintenance**)" (1975, p.99-100).

1364

FUNCTIONS OF A SYSTEM (The five basic classes of) ²⁾

Following D. KATZ and R.L. KAHN (1966) the five basic **classes** of systemic functions are:

- **Production**: i.e. **transformation** of the **inputs** into products or services, characteristic of the system;
- **Maintenance**: i.e. obtaining from the **environment** the **inputs** needed to maintain the activities of the system;
- **Manutention**: maintaining the systems internal **coherence**;
- **Adaptation**: production of the **changes** needed to allow the system's **survival** in its **environment**;
- **Direction**: coordination of the **activities** of all the **subsystems** and designing **goals** and means to achieve them.

1365

FUNNEL

→ **Vortex**

1366

FUSCHL GROUP ¹⁾ – 4)

A group of members of various systemics societies who meet every two years in the Austrian town of FUSCHL (near SALZBURG).

The Fuschl Group basic tenet is that systems concepts should be applied in a **useful manner** to the better co-participative (i.e., with the effective participation of all the **stakeholders**) **management** of **human systems**. Its original mentor was B.H. BANATHY. The members, generally about 20 of them, organize themselves in workshops around some 3 or 4 pre-defined thema. Some months before the meeting, each member mails to the others an "input paper" in which she/he states her/his views on the subject she/he selected as of her/his main interest. However, no so-called papers are presented at the meeting, which is entirely dedicated to "open **conversations**".

At the end of the meeting, each workshop offers a statement of its views about the debated subject. A general report is prepared later on for the **International Federation for Systems Research**, which sponsors the meetings.

The members commit themselves to use and promote the practical proposals and **methods** produced by the "**conversations**".

Some of the main thema of the recent **conversations** have been:

- **Development** in systemic terms
- **Models** for a better **education**
- **Models** for a better social **organization**
- **Methodology** of **co-participative design**

Supplementary Fuschl conversations are organized during interim periods, in other countries (Spain, Greece, United States, etc...).

The Fuschl Group also sponsored the publication of the "International Systems Science Handbook" (1993), whose edition was organized by R. RODRIGUEZ DELGADO, founder of the **Spanish Society for General Systems**.

1367

FUZZIFICATION ²⁾ – 3)

"The **operation** (which) has the effect of transforming a nonfuzzy **set** into a **fuzzy set** or increasing the fuzziness of a **fuzzy set**" (L. ZADEH, 1973, p.32).

This operation defined by L.A. ZADEH, results of the application of a specific function called a *fuzzifier* (Ibid).

1368

FUZZINESS: An epistemological evaluation ³⁾

According to M. ZELNY: "Any notion of fuzziness can be meaningful only in dependency on **human systems**, human **observers**, and human tools and **strategies** to describe reality: That is, human beings are the only and exclusive source of fuzziness in **linguistic** labelling – there is no other source" (1984, p.301).

While this is evident, it is also true of any **knowledge** and will remain so until some hypothetical non-human **knowledge** should appear.

Fuzzy **models** try to codify, measure and diminish **ambiguities** in natural **languages** and **labels** and, quoting I.R. GOODMAN and H.T. NGUYEN, we should remember that "The most complex mathematical expressions are meaningless unless they represent concepts at least theoretically expressible in natural **language**" (1985, p.13).

1369

FUZZY ALGORITHM ⁵⁾

"An ordered **sequence** of instructions (like a **computer program**) in which some of the instructions may contain **labels** of **fuzzy sets**, e.g.

- Reduce *x* *slightly* if *y* is *large*
- Increase *x* *very slightly* if *y* is *not very large and not very small*
- If *x* is *small* then stop; otherwise increase *x* by 2" (L.A. ZADEH, 1973b, p.30).

L.A. ZADEH states: "By allowing an algorithm to contain instructions of this type, it becomes possible to give an approximate fuzzy-algorithmic characterization of a wide variety of complex **phenomena**..." (Ibid).

He adds: "Roughly speaking, a fuzzy algorithm is an ordered **set** of fuzzy instructions which upon execution yield an approximate solution to a specified problem. In one form or another, fuzzy algorithms pervade much of what we do. Thus we employ fuzzy algorithms, both consciously and subconsciously, when we walk, drive a car, search for an object, tie a

knot, park a car, cook a meal, find a number in a telephone directory, etc... Furthermore, there are many instances of uses of what, in effect, are fuzzy algorithms in a wide variety of fields, especially in **programming**, **operations research**, psychology, **management science**, and medical diagnosis.

"The notion of a fuzzy **set** and, in particular, the concept of a fuzzy conditional statement provide a basis for using fuzzy algorithms in more systematic and hence more effective ways than was possible in the past" (Ibid, p.38).

1370

FUZZY CLASSIFICATION ²⁾ – 5)

A classification in which the membership of an **element** in a specific **class** do not exclude its membership in another **class**.

For example, a middle size apple could be classified either as "not very small", or "not very big".

1371

FUZZY CONDITIONAL STATEMENTS ⁵⁾

L.A. ZADEH explains how fuzzy **variables** can be described through fuzzy conditional statements: "In particular, if *x* and *y* are linguistic **variables**, the conditional statements describing the **dependence** of *y* upon *x* might read (the following italicized words represent the values of fuzzy **variables**):

- "If *x* is *small* then *y* is *very large*
- if *x* is *not very small* then *y* is *very very large*
- if *x* is *not small and not large* then *y* is *not very large* and so forth" (1973b, p.29).

1372

FUZZY DECISIONAL ALGORITHM ⁵⁾

"A fuzzy **algorithm** which serves to provide an approximate **description** of a **strategy** or **decision rule**" (1973b, p.43).

According to L.A. ZADEH: "Commonplace examples of such **algorithms**, which we use for the most part on a subconscious **level**, are the **algorithms** for parking a car, crossing an intersection, transferring an **object**, buying a house, etc..." (Ibid).

It would be very interesting to know how the **brain** constructs such decisional and behavioral **algorithms**.

1373

FUZZY DEFINITIONAL ALGORITHM ⁵⁾

"A finite **set** of possibly fuzzy instructions which define a **fuzzy set** in terms of other **fuzzy sets** (and possibly itself, i.e. recursively) or constitute a procedure for computing the grade of membership of any **element** of the universe of discourse in the **set** under definition" (L.A. ZADEH, 1973b, p.40).

ZADEH explains: "In the latter case, the definitional algorithm plays the role of an identificational algorithm, that is an algorithm which identifies whether or not an **element** belongs to a **set** or, more generally, determines its grade of membership" (p.40).

1374

FUZZY GENERATIONAL ALGORITHM ⁵⁾

"(An **algorithm** which) serves to generate rather than define a **fuzzy set**" (L.A. ZADEH, 1973b, p.40).

ZADEH states: "Possible applications of generational algorithms include: generation of handwritten characters and **patterns** of various kinds; cooking recipes; generation of music; generation of sentences in a natural **language**; generation of speech" (Ibid).

1375

FUZZY RELATIONAL ALGORITHM ⁵⁾

An **algorithm** that "serves to describe a **relation** or **relations** between fuzzy **variables**" (L.A. ZADEH, 1973b, p.42).

L.A. ZADEH introduces moreover a special **class** of fuzzy relational algorithms, the *fuzzy behavioral algorithms* which are "used for the specific **purpose** of approximate **description** of the **behavior** of a system" (Ibid).

1376

FUZZY SET ⁵⁾

"A **set** wherein there are degrees of membership varying between 0 = not a member and 1 = is a member. The **set** of "tall people" is one such **set**" (T.F.H. ALLEN & T.B. STARR, 1982, p.268).

A more formal definition is: "A **set** *E* with a map *f* from *E* into unit interval [0,1]" (A. KAUFMANN, 1973). C.P. BRUTER, who quotes this definition, adds that "J.A. GOGUEN generalized this notion by considering *f* as a **map** from *E* into a **lattice**" (GOGUEN, 1967, in BRUTER, 1975, p.120).

1377

FUZZY SETS (THEORY of) ²⁾ – 3)

L.A. ZADEH writes: "The theory of fuzzy sets is, in effect, a step toward a rapprochement between the precision of classical mathematics and the pervasive imprecision of the real world – a rapprochement born of the incessant human quest for a better **understanding** of mental **processes** and **cognition**..."

"We have been slow in coming to the realization that much, perhaps most, of human **cognition** and **interaction** with the outside world involves **constructs** which are not **sets** in the classical sense, but rather "fuzzy sets" (or **subsets**), that is, **classes** with unsharp **boundaries** in which the **transition** from membership to non-membership is gradual rather than

abrupt. Indeed it can be argued that much of the logic of human reasoning is not the classical two-valued or even multivalued logic, but a logic with fuzzy **truths**, fuzzy connectives, and fuzzy **rules** of inference" (1973a & 1973b, p.28).

"In our view, it is this fuzzy, and as yet not well understood, logic that plays a basic role in what may well be one of the most important facets of human thinking, namely, the ability to *summarize information* – to extract from the collection of masses of **data** impinging upon the human **brain** those and only those subcollections which are relevant to the performance of the task at hand...

"Thus, the ability to manipulate fuzzy sets and the consequent summarizing capability constitute one of the most important assets of the human mind as well as a fundamental characteristic that distinguishes human intelligence from the type of **machine intelligence** that is embodied in present-day digital computers" (1973b, p.28-29).

Fuzzy sets theory includes fuzzy **subsets**, fuzzy **functions**, fuzzy **categories**, fuzzy **topological spaces**, fuzzy **structures**, etc...

G

1378

GAIA hypothesis ¹⁾

The hypothesis according to which the Earth, as a planet, is a global adaptive and regulated system, in permanent **evolution** as a result of the **interactions** between its physical and living **components**.

This hypothesis has been presented in 1979 by J. LOVELOCK. In his view, GAIA is "... a complex entity involving the Earth's **biosphere**, atmosphere, oceans and soil; the totality constituting a **feedback** or **cybernetic system** which seeks an optimal physical and chemical **environment** for life on this planet. The maintenance of relatively constant conditions by active **control** may be conveniently described by the term "**homeostasis**" (1979, p.11). LOVELOCK writes that his hypothesis: "is in contrast to the conventional wisdom which held that life adapted to the planetary conditions, as it and they evolved their separate ways" (p.152).

Earth **homeostasis** could possibly be accepted in the very general cosmic sense, as an evolutive celestial body that maintains an **oscillating** global **equilibrium** within the solar system. However GAIA itself evolves. As observed by I. PRIGOGINE and P.M. ALLEN: "... the Earth is not in **thermodynamic equilibrium** and... the **flow** of solar **energy** in which it is bathed is sufficient to ensure that for the sys-

tems of interest the relevant **thermodynamic regime** is not that of **equilibrium**, or of **near equilibrium**, but rather that of **far-from-equilibrium**" (1982, p.6).

GAIA hypothesis has generated a considerable current of diverging opinions (See for ex. T. BEARDSLEY – Scientific American, Dec. 1989, p.35-6). Until now, the debate remains open.

To confront all this criticism and in collaboration with A.J. WATSON, LOVELOCK has created "Daisy World", a model meant to justify his hypothesis (1983).

The GAIA hypothesis could possibly be compared with LOTKA's **world engine concept**.

More recently P. BAK emitted the following opinion: "One might think of **self-organized criticality** as the general, underlying theory for the Gaia hypothesis. In the **critical state** the collection of species represents a single coherent **organism** following its own evolutionary **dynamics**. A single triggering **event** can lead an arbitrary large fraction of the **ecological network** to **collapse**, and eventually be replaced by a new stable **ecological network**. This would be a "mutated" global **organism**. At the **critical point** all species influence each other. In this state they act collectively as a single **meta-organism**, many sharing the same fate. This is highlighted by the very existence of large-scale extinctions... Within the **self-organized criticality** picture, the entire **ecology** has evolved into the **critical state**" (1996, p. 155-6)

1379

GAIN ²⁾

The increase of a **process** or **function** resulting of the **action** of a positive **amplification** device.

Gain is basically a term adapted from engineering **control** theory. If the **positive feedback** maintains itself without any countervailing negative one, it amplifies and accelerates the **process**, ending up in a **runaway event**, which may easily destroy the affected system.

For the opposite, see "**damping**"

1380

GAME OF LIFE ²⁾

A game based on a **cellular automaton** whose **initial state** and **behavioral rules** are specified.

J. CASTI, who describes the "game" (1994, p.223-8), observes that it is not really a game, since there are no players; nor are any **decisions** to be made".

P. BAK and K. CHEN describe thus John H. CONWAY's famed game: "The game of life simulates the **evolution** of a **colony** of living **organisms** and mimics the generation of **complexity** in nature" (1991, p.32).

This may be a somewhat overextended claim. As all the **elements** are of the same **class** and all the **rules** apply uniformly in **space** and **time**, it would seem that the game may not be more than a tool for modelling **composite systems** (as opposed to **integrated systems** – see hereafter).

BAK and CHEN pursue: "To start the game, the pieces, or **organisms** are placed at **random** on a board composed of square sites. Each site is occupied by at most one **organism** and is surrounded by eight neighboring sites. To determine the status of any site at each turn, one must count the number of **organisms** that occupy the eight neighboring sites. If one count two live sites around an empty or occupied site, then the status of the site does not change. If one counts three live sites around a site, the live sites give birth to a new **organism** or sustain the life of an old **organism**. In all other cases, an **organism** will die from **overcrowding** or loneliness.

"The game continues according to the **rules** until it comes to "rest" in a simple **periodic state**, containing stable **colonies**" (Ibid).

The game may also end with the total disappearance of the **colony**, or when a final **state** is reached, in which no **change** is anymore possible (analogous to a "**frozen state**").

Other possibilities are: emission of an independent **configuration**, that starts to evolve in its own way, and can at times be absorbed by an "eater"; **self-reproduction** of the original system and, in CASTI words: "... a veritable cornucopia of strange and captivating **patterns**" (p.225).

As a synthesis, the basic conditions of the game are:

- a limited (or supposedly illimited) **substrate** in which its **evolution** takes place
- a specified **structure** of this **substrate** (as for example "square sites")
- an unique type of **elements**, all of them similar
- a given **initial state**
- a **set of transformation rules**, excluding any **change** in the formerly stated conditions

BAK and CHEN perturbed the game "by adding an extra "live **cell**" and found that "the system often sustains long transients of **activity**" (Ibid) ...and that, when measuring "...the total number of births and deaths in the "**avalanche**" after each additional **perturbation**... the **distribution** was found to be a **power law**, indicating that the system has organized itself to a **critical state**.

"We also found that the **distribution** of live sites is a **fractal** that can be described by a **power law**. The average number of active sites within a distance *r* from a given active site was proportional to *r* to the power of *D* where *D* turned out to be about 1,7" (1991, p.33).

1381

GAME (Positive Sum)^{1) - 2) - 4)}

A game which produces net **gains** for one of the players

Truly, any game, when considered *globally* in *time*, should be considered a zero-sum game: The **gains** of some players are the losses of other players.

However, a somewhat viciated concept of so-called positive-sum games has crept within the minds of numerous people, specially in economics.

Interestingly, G. BATESON observes: "A social system is, as von NEUMANN and MORGENTHAU point out, comparable to a non-zero sum game in which one or more coalitions of people play each other and *against nature*. The non-zero sum characteristic is based on the fact that value is continually extracted from the natural **environment**" (1973, p.94)... which, in contradiction with general popular belief, but in accord with the **2d principle of thermodynamics**, is not an inexhaustible treasure chest.

Only by global **recycling**, using available *permanently renewable* sources of **energy**, could this game be maintained. If this is not taken care of, the future generations could face a dire "negative-sum game".

1382

GAME THEORY^{1) - 2) - 3)}

"A mathematical theory devoted to the study of problems of **strategy**, **conflict** and **cooperation**" (M. SHUBIK, 1967, p.151).

K. KRIPPENDORFF describes game theory as "A general theory of rational **behavior** for **situations** in which 1) two (two-person games) or more (multi-person games) **decision makers** (players) have available to them 2) a finite number of courses of **action** (play) each leading to 3) a well defined outcome or end with **gains** and losses expressed in terms of numerical payoffs associated with each combination of courses of **action** and for each **decision maker**. The **decision makers** have 4) perfect **knowledge** of the **rules** of the game, i.e. 1), 2) and 3) but no **knowledge** about the opponent's moves, and are 5) rational in the sense of making **decisions** that optimize their individual **gains**" (1986, p.32).

This "capitalistic" **rationality** is of course a quite narrow view of rational **behavior** (see below).

KRIPPENDORFF adds: "In a **zero-sum game**, one person wins what the other loses. In other **situations gains** and losses may be unequally distributed, which allows the **representation** of numerous competitive and **conflictive situations**".

And "The theory proposes several solutions, e.g., in a **minimax** strategy each participant minimizes the maximum loss the other can impose on him. A mixed strategy involves probabilistic **choices**".

"Experiences with such games revealed conditions for **cooperation**, defection and the persistence of **conflict**." (Ibid).

Games have been used – possibly overused: see hereafter – to modelize specific **situations** in economics and **management science**.

T.R. BURNS and L.D. MEEKER make the following comments about the rules proposed by J.von NEUMANN and O. MORGENTHAU (1964), in the simplest case of a 2-persons game.

"1) The actors lack the will or opportunity in the **action situation** to transform the **structure** of the game, in particular to develop or discover new options.

"2) The actors have alienative or antagonistic social relations – as distinct from having only conflicting preferences (Actors may be in opposition on one **level**, for instance, with respect to **evaluations** of outcomes in a concrete **interaction situation**, without being in opposition on others, for instance, they have solidary **relationships**).

"3) **Stability** is assumed on higher **levels** of **relationships** between the actors as well as on the **level** of their preference **structures** (for which there is an **equilibrium point**)" (1976, p.112).

Synthetically, games are a much simplified **analogy** of real **situations**. Some uses of games may even border the **metaphor** and lead to quite dubious conclusions.

1383

GAME (Zero Sum)^{1) - 2)}

"... a game where the amount of 'winnable goods' (or **resources** in our terminology) is fixed" (F. HEYLIGHEN, 1992, p.4).

Underlying the zero-sum game **concept**, we find the "bank" problem: **resources** are limited and this is critical for unlimited **competition**. In HEYLIGHEN's words: "Whatever is gained by one actor, is therefore lost by the other actor, the sum of gained (positive) and lost (negative) is zero" (Ibid).

On the contrary: "(in) a non-zero sum game all participants can win property from the "bank". In principle, in monopoly, two players could reach an agreement and help each other in gathering a maximum amount from the "bank" (Ibid).

One of the most serious problem of our time is the general implicit assumption – or better said, conviction – that our planetary bank is inexhaustible.

1384

GAMES as problems models^{1) - 2) - 3)}

R.L. ACKOFF scrutinized games as **models** for problems in the following terms:

"A person (or group) can be said to be in a problem **situation** if the following conditions exist:

1. He has one or more unsatisfied desires; that is, he wants something that he does not have, and

2. He has available alternative ways of pursuing the objective(s) and these alternatives are not equally effective: that is, he has a real **choice**.

... "It will be observed that in a game, as conceived in Game Theory, the first two conditions are satisfied. Utilities or valued outcomes are involved, as are unequally effective plays or **strategies**. To have a game, however, several additional conditions are required:

1. the possible plays can be specified in advance.

2. there is a **set** of well-defined end-states.

3. A specified pay-off is associated with each end- **state**.

... "In a game the problem is already formulated for the **decision** maker and hence he is deprived of the **information** which is required to formulate a real problem in this form. In a real **problem-solving situation** the **decision** maker is not given a game to play, he must extract it out of the **situation** itself. A pre-formulated problem is a contrived exercise in which the **decision** maker is presented with incomplete **information**. The procedure by which he does or should solve this exercise it not necessarily the same as what he does or should do in a real problem **situation**..." (1959, p.147-8).

As to the study of real **situations**, see J. WARFIELD's **Generic Design**.

1385

GAMES (von NEUMANN's)²⁾

G. BATESON states very clearly the nature and limits of von NEUMANN's games:

"1) The players ... are by hypothesis, motivated only in terms of a single **linear** (sc. monetary) **scale** of **value**. Their **strategies** are determined: a) by the **rules** of the hypothetical game; and b) by their intelligence, which is, by hypothesis, sufficient to solve all problems presented by the game. Von NEUMANN shows that, under certain definable circumstances depending upon the number of players and upon the **rules**, coalitions of various sorts will be formed by the players, and in fact von NEUMANN's analysis concentrates mainly upon the **structure** of these coalitions and the **distribution** of **value** among the members" (1973, p.94).

Thereafter, BATESON shows why we should be careful in trying to use these **models** in social sciences:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"2) von NEUMANNIAN systems differ from human societies in the following respects:

a) His "players" are from the start completely intelligent, whereas human beings learn...

b) The mammalian **value scale** is not simple and monotone, but may be exceedingly complex (BATESON gives psychological and even biological examples)...

c) In the von NEUMANNIAN system the number of moves in a given "play" of a game is assumed to be finite. The **strategic** problems of the individuals are soluble because the individual can operate within a limited **time** perspective...

d) The von NEUMANNIAN players are, by hypothesis, not susceptible either to economic death or to boredom. The losers can go on losing forever, and no player can withdraw from the game..." (p.94-95).

In synthesis, real social interplay cannot be circumscribed by rigorously limited **rules**, isolated from **context**.

1386

GAP ANALYSIS²⁾

A "**planning** technique used to analyse if and where any gap may occur between plans and reality" (I.G. BLOOR, 1987, p.17).

BLOOR presents the technique as a financial one. It seems however that it could offer quite a wider scope. He writes that any gap "may be attributed to many factors, such as **changes** in volumes of sales, obsolescence in equipment, product or service or any market forces aspects" (Ibid) He defines "gap closing **methods**".

Gap analysis seems applicable more generally to any possible difference between defined **goals** and real **situations**, in the **activity** of any kind of **organizations**. Examples could be the **evaluation** of schooling systems, sanitary systems, traffic systems, etc.

1387

GARDEN OF EDEN²⁾

"An **initial configuration** in a **cellular automaton** which cannot be produced from any previous **configuration**" (P. GREUSSAY, 1988, p.1327).

The **concept** corresponds to the "Garden of Eden theorem", demonstrated by E. MOORE which states that there are **machines** that cannot be built, i.e. that no **machine** exists that can build all **machines**.

Such a "Garden of Eden" **configuration** has been discovered in 1974 by J. HARDOUIN DUPARC from BORDEAUX University for CONWAY's **Game of Life** and demonstrated not to be deducible from any previous **configuration**.

1388

GATE ELEMENT²⁾

A **processor** through which the system receives or emits. the **inputs** or **outputs** which affect its **behavior** (definition adapted from J.L.LE MOIGNE, 1977, p.89).

LE MOIGNE uses this concept, proposed by KLIR and LÖFGREN as a part of his general **model** of the system.

These **processors** constitute a finite **set** : "... they play a specially privileged part in the definition of the "**Système Général**" in view that it is through these that the **Representation System** (i.e. *the observer*) observes the behavioral sequences of the **object** to be modeled (Ibid).

LE MOIGNE adds: "It results from this definition that a **closed system** has no gates (i.e. *boundary*) ! Or in a less paradoxical fashion, that its **environment** is empty" (Ibid).

Let us remember that it would be better to speak of an "**isolated system**", which is a pure **abstraction** and no **model** of any **concrete system**.

1389

GENERAL ADAPTATION SYNDROME^{2) - 5)}

"The manifestations of **stress** in the whole body, as they develop in **time**" (H. SELYE, 1975, p.466).

The G.A.S. is the **set** of non specific reactions of an **organism** submitted to the protracted **action** of some aggressive **agent**.

This concept was introduced in biology by SELYE, according to whom: "The G.A.S. evolves in three distinct stages: alarm reaction, stage of resistance, stage of exhaustion" (Ibid).

The author explains that the second stage develops solely if the aggression and exposure to the noxious agent is not so violent as to produce quick death: "... no living **organism** can be maintained continuously in a **state** of alarm... If **survival** is possible at all, this alarm reaction is necessarily followed by a second **phase**, which I called the stage of resistance" (p.37).

In accordance with P. VENDRYES' **concept** of the use of stored **reserves** to regulate **functions** (biological and in general) during the stage of resistance the system uses part or all of the specific - and in some cases, non-specific - **reserves** at its disposal in order to re-establish **homeostasis**.

If **reserves** are sufficient, the system returns to **homeostasis**. If not, "... after still more prolonged exposure... this acquired **adaptation** is eventually lost" (p.38) and the system enters in a third phase, the stage of exhaustion, which leads it promptly to its destruction.

While this G.A.S. concept and the associated **strain** and **stress** concepts are biological ones, they could quite probably be generalized to psychology, as proposed by F. E. HORVATH

(1959) and social sciences, as suggested by M. Mc LUHAN and by the well known popular dictum: "It was the last straw that broke the camel's back"!

1390

GENERAL EQUILIBRIUM THEORY

→ Nash Equilibrium

1391

GENERAL PROBLEM SOLVER^{1) - 2)}

M. RINGLE synthesizes and evaluates as follows the General Problem Solver Program developed by NEWELL and SIMON: "GPS was designed to extract key features from problems, analyze the logic of the problem, generate procedures for dealing with the problem, and then attempt to solve it. The focus was on the generality of GPS, i.e., its ability to handle a wide range of **situations**, and on its capacity to develop its own **heuristics**. Unfortunately, a careful examination of the major **routines** of GPS reveals that the key-feature analysis depends of the logic found in the "table-of-**connections**" which is pre-programmed, and the technique-generator depends on a selection, by GPS from its "main-**methods**" table. In short, the critical features which would emancipate GPS from the stigma attached to traditional **mechanisms** are obscured but not removed. Given a vague problem to solve (or one which fails to fit into the logical schemata GPS uses for key-feature extraction) GPS is at a loss. Moreover, increasing the size of the table-of-**connections** or the main-**methods** group would not help to answer the initial objection, that the **program** fails to actually "cognize" its **environment**, although it would serve to increase GPS's ability to *appear* cognitive.

"The real problem lies in the fact that the task **environment** for GPS and other AI **programs** is only an "internal **representation**" of the world in a limited way. GPS does not produce its own **symbols** and **values**, but merely manipulates the **symbols** and **values** according to its pre-programmed instructions" (1976, p.8).

In short, the GPS is merely a "Partial Problem Solver" (which of course, is not to be despised).

Generally, this is a result of the necessarily **algorithmic** character of the sequential computers **programs**.

→ "General Systems Problem Solver".

1392

GENERAL SYSTEM RESEARCH: Original program^{1) - 3)}

J.W. SUTHERLAND stated in the following way the original research program of the **Soci-**

ety for General System Research (now International Society for the Systems Sciences):

"- to investigate the **isomorphy** of **concepts**, laws, and **models** in various fields, and to help in useful transfers from one field to another

"- to encourage the development of adequate theoretical **models** in fields which lacks them

"- to minimize the duplication of theoretical effort in different fields

"- to promote the unity of science through improving **communication** among specialists". He added: "The key is the search for **isomorphisms** among real world **phenomena** for these, when identified, permit the development of explanatory **models** or allegories via **analogy-building**" (1973, p.20).

A growing number of systemists deplore that these aims have not been pursued in a really efficient manner. While "systems" – whatever the **meaning** given to this term – were introduced in a number of Universities departments, they were in many cases dismantled (D. McNEIL, 1993a). There seems to exist two principal causes:

- The general **transdisciplinary** systems worldview is *not* a classical subject to be taught as for example micro-biology or astrophysics. As such it does not fit well in any specific curriculum.
- Systemics have been frequently confused with much more limited approaches or subjects, as for example **Systems Dynamics**, **Operation Research**, or **Systems Engineering**. It has also at times been presented as a vague general philosophy, without much specific **content**.

It seems urgent to go back to the original program, as described by SUTHERLAND, avoiding reduction to some specialized applications, as well as academic seclusion. Moreover, systemics, as a **methodology** to understand and manage **complexity**, is for *everybody*, i.e. for businessmen, politicians, economists, ecologists, etc... and also for John and Jane Citizen, from childhood on, in order to enable them to find their way in this ever more complex world.

It should be noted that, since the time SUTHERLAND wrote these lines, a quite different **process** has covered a growing importance: Abstract **models** *invented* principally by mathematicians and logicians, as for example **catastrophes**, **fractals**, **fuzzy sets**, or **percolation** in **composite systems**, led to the discovery of new **phenomena**, or new interpretations of **phenomena**, already known, but until then ill-understood.

But again, the very general **isomorphies** so discovered remain shrouded in specialized mists, unassimilated in their general **meaning** and mostly ignored even by many systemists.

1393

GENERAL SYSTEMS LAWS^{1) – 3)}

General systems "laws" are statements of mostly qualitative nature, as for example W.R. ASHBY's law of **requisite variety**, or J. WARFIELD law of **linguistic drift**.

They are not used to obtain precise or quantitative answers as in physics or chemistry, but to define **relationships** of a general character that can be found in numerous and quite different systems.

They could be considered as memoranda of very general properties, as for example in the case of: "The **whole** is more than the sum of the **parts**" or its complement, as aptly stated by G. WEINBERG: "The **part** is more than a fraction of the **whole**" (1975, p.43).

They are also tools for **generalization** and construction of **transdisciplinary models**. As such, they should be used with restraint, taking carefully in account any special condition that would impede **generalization** or need qualification.

1394

GENERAL SYSTEMS Metaphors³⁾

R.M. SNOW states: "The conceptual scheme of General Systems Theory relies heavily on **organismic metaphors** because of its roots in theoretical biology. All systems are described as one would describe living things, using technical biological as well as developmental terminology.

"Any system, for example, can be viewed in terms of its **life cycle**. All are "born" and subsequently "grow". They pass through "youth" and "maturity" to "death". A system's **self-regulatory activity**, moreover, is analogous to the "homeostasis" of animals and plants. And types or "species" of systems are often described as evolving in either Darwinian or Lamarckian sense" (1993, p.142).

SNOW has however some reservations. She adds: "The systems **community** is able to communicate ...through the mixed **metaphors** they share. There is a problem, however. Few systems theorists are aware of the precision of their **language**, and how it relates the systems sub-schools to each other. As a result, many systemic "texts" go unread by those outside the **field** – or even outside the sub-school in which they are written" (p.149).

Systemists should seek to acquire a deeper **understanding** of the nature and possible uses (or misuses) of their metaphoric **language**.

1395

GENERAL SYSTEMS MODELS^{1) – 2) – 3)}

J.W. SUTHERLAND adscribes the following necessary characteristics to general systems models:

" – The models should have premises which are *fully explicated* such that we, as completely as possible, eliminate any tacit predicates (**axiological**, **ontological**, or **epistemological**).

" – The models should, to the extent feasible or economical, treat all determinants of a **phenomenon** as *endogenous*.

" – The logical or substantive **connections** among the determinants (i.e. **state-variables**) in our models should be both *eidetic* (Note: from the Greek "eidōs": form, shape) and *non-elliptical*.

" – Our models should, to the extent that the properties of the **phenomenon** at hand permit, be *nomothetic* (Note: i.e., usable, from the Greek "nomos": usage, law) in character, but models should always be *apodictical*" (Note: i.e. clearly proven) (1973, p.91).

According to SUTHERLAND, these prescriptions are designed to avoid unwarranted and assumptive **reductionism** (of the kind based on sweeping and invalid **analogies**) and expediency, or, we should add, downright fudging.

We must however assume that the business of replacing enigmatic observed **arrays** of **facts** by comprehensive but very difficult to prove **abstractions**, is quite risky.

As observed by G. WEINBERG: "The most dangerous pitfall in developing **category** systems is imagining that one system of **paradigms** is more "real" than another" (1975, p.34).

General systems models are by nature models of second degree order, i.e. models of properties common to a number of more specific models. For example, **regulation** in general is a global model including the basics of many specific regulations in different disciplines.

As such, it can be used:

- as a **transdisciplinary metalanguage** among specialists confronted by complex **situations**.
- as a tool in any special trade to gain useful insights on overlooked aspects of **phenomena**.

However, as acutely observed by K. BOULDING, one should be very careful as nowadays nobody can: "...hope to know more than a very small fraction of what is known by somebody. The general systems man, therefore, is constantly taking leaps in the dark, constantly jumping to conclusions on insufficient evidence, constantly, in fact, making a fool of himself" (1964, p.30).

... A kind of foolishness we however are in dire need of, if we are not to loose our grasp on complex situations!

1396

GENERAL SYSTEMS PROBLEM SOLVER^{2) - 3)}

G. KLIR refers himself to the General Systems Problem Solver (GSPS), whose: "...kernel... is a *hierarchy of epistemological categories of systems*, which represents the most fundamental *taxonomy* of systems...

"At the lowest level of the **epistemological hierarchy**, we define an *experimental frame* in terms of appropriate **variables**, their **state sets** (**value sets**) and an interpretation of these as real worlds attributes. In addition, some supporting medium (such as **time**, **space**, or a **population**) within which the **variables** change their **states** must also be specified. Furthermore, **variables** may be classified as **input** and **output variables**.

"An *experimental frame* (also called a *source system*) may be viewed as a **data description language**. When actual **data** described in this **language** become available, we move to the next **level** in the **hierarchy**. Systems on this level are called **data systems**.

"When **variables** of an *experimental frame* are characterized by a relation among them, we move to a **level** that is still higher in the **hierarchy**. It is assumed on this **level** that the **relationship** among the **variables** is **invariant** with respect to the supporting **medium** involved... That is, it is **time-invariant**, **space-invariant**, **space-time-invariant**, **population-invariant**, etc...

"We say that a **data system** is represented by a **behavior system** if, under appropriate initial or **boundary** conditions, the support-invariant relation of the latter can be utilized for generating the **data** of the former... A **behavior system** is capable to generate for example, **predictions** or **retrodictions** of the **variables** involved. Moreover, it provides us with an explanation of the **behavior** of the **variables** within the given supporting **medium**.

"Climbing further up the **hierarchy** involves two principles of **integrating** systems as **components** in larger systems. According to the first principle, several **behavior systems** (or sometimes lower **level systems**) that may share some **variables** or interact in some other way are viewed as **subsystems** integrated into one overall system. Overall systems of this sort are called **structure systems**. The **subsystems** forming a **structure system** are often called its **elements**.

"When **elements** of a **structure system** are themselves **structure systems**, we call the overall system a *second order structure system*. Higher order **structure systems** are defined in the same way...

"The key feature of the **epistemological hierarchy** is that every system defined on some **level** in the **hierarchy** entails **knowledge** associated with all corresponding systems on lower **levels** and, at the same time, contains some **knowledge** that is not available in any of these lower **level systems**" (1993, p.32-33).

The interest of the GSPS is that all **concepts** and **models** used in general **systemics** and **cybernetics** can be applied within its **frame**. However, **chaotic systems** should possibly need some general modelling adaptations.

The GSPS should not be confused with SIMON and NEWELL's **General Problem Solver**.

1397

GENERAL SYSTEMS RESEARCH: Operational prescriptions²⁾

According to J.W. SUTHERLAND: "The general systems theorist brings to his discipline or areas of investigation the following operational tenets:

- The postulate that non-mechanical **wholes** are not simple sums (or products) of the properties of their **parts**.
- A preference for a *holistic* as opposed to a **reductionist** analytical modality when treating the "organic" or "**open**" **systems** which predominate in the social and behavioral sciences.
- The concentration on *macrodeterminacy* as an **isomorphic** property of many (or most) **complex systems**, and as a fundamental point for analytical departure.
- The employment of **ideal-types**, **taxonomies** and typologies as fundamental vehicles for the advancement of science in complex phenomenal **domains**" (1973, p.34).

As to the **holistic** modality, it should not be opposed to the analytic one: both seem really complementary. **Holistic** (i.e. **interconnective**) aspects had to be strongly restated, but they are certainly a **frame of reference** for analysis and **reconstructability**, not at all exclusive of specific disciplinary and analytic research, directed to the individual nature of interconnecting **parts** and **elements**.

As to "**macrodeterminacy**", let us remember that the **simultaneity of events** in different **parts** of the **complex system** limits it up to a point, as shown by the theory and models of **chaotic determinism**.

Taxonomies and typologies are certainly very important tools and systems sciences offer a very significant example: J. MILLER's **taxonomy of living systems**.

1398

GENERAL SYSTEMS THEORY^{2) - 3)}

A collection of **concepts**, **models** and **laws** referred to the nature and **behavior** of **complex systems**.

M. BUNGE observes: "Paradoxically enough, this is not a single theory but a whole **set** of theories - **automata** theory, **linear systems** theory, **control** theory, **network** theory, general Lagrangian **dynamics**, etc. - unified by a philosophical framework... We shall call *systemics* this **set** of theories that focus on the structural characteristics of systems and can therefore cross the largely artificial barriers between disciplines" (1979, p.1).

This compiler agrees with BUNGE and consequently, the term "systemics" is generally used in this dictionary in place of the expression "General Systems Theory".

G.S.T. tries to respond to the need to research organized **complexity** and is complementary to the study of organized simplicity (starting with classical mechanics) and inorganized **complexity** (as f. ex. classical statistical physics).

According to I.V. BLAUBERG, V.N. SADOVSKY and E.G. YUDIN, the main tasks of the General Systems Theory are as follows:

- "1. The definition of the "system" concept and all other concepts related to it
2. The **classification** of systems and the discovery of laws pertaining to systems in general and to special **classes** of systems.
3. The construction of **models** (of various degrees of generality) of system **behavior** (functioning, development).
- 4 The development of a special formal apparatus (logical and methodological included) for the solution of problems indicated in (1)-(3) and for formulating the general theoretical foundations of special systems **concepts** such as the theory of **control systems**, the theory of **automata** and the theory of **information systems**" (1977, p.162).

Of course, these very basic tasks should be constantly sustained and validated by the **observation** and study of the numerous **objects** that may be conceived and modeled as systems.

The cited authors add the following comment (by M. MESAROVIC, 1964, p.4,5): "General Systems Theory, as a theory of general **models** must encompass the specific theories concerned with the more restrictive types of **models**; e.g. the theory of **linear systems**, the theory of **Markov systems**, etc. GST also unifies the theories of different aspects of system **behavior** such as **communication**, **control**, **adaptation**, **learning**, **self-organization**, theory of computing and **algorithms**, etc."

"Accordingly, the greatest difficulty in constructing a general systems theory, in MESAROVIC's view is "to find the proper **level of abstraction**" (BLAUBERG et al, p.166).

Possibly, we should work on different **levels** in order to define in every case the most properly adjusted one.

1399

GENERAL SYSTEMS THEORY: a Set of precepts^{1) - 3)}

J.W. SUTHERLAND enounced as an "epistemological platform", the following integrated set of precepts for G.S.T.:

- A belief in the scientific utility of (and the limited existence of) **phenomenal isomorphisms**.
- A belief in the perquisital nature of proper theory, coupled with the conviction that empirical **validation** should be the arbiter of scientific **truth**.
- A postulation of the critical role to be played by **analogic models** in complex **phenomenal domains**.
- A preference for 'organic' referents within the social and behavioral sciences (as opposed to the mechanical referents of classical physics, etc.).
- A preference for a **holistic** analytical modality (predicated on hypothetico-deductive **operations**) as opposed to the **reductionist**-inductivist modality.
- A demand that instances of **macrodeterminacy** among complex 'organic' **phenomena** be fully exploited.
- The postulation that **ideal-type** and **taxonomic constructs** are the most efficient vehicles for **phenomenal** analysis in the social and behavioral sciences" (1973, p.19).

Of course the modes of "empirical **validation**" depend at least in part on the way of setting the "question marks". As to the preference for "organic referents in social and behavioral sciences", it should not be exclusive: **dissipative structuration** and **networks**, for example may provide useful models. As to "**macrodeterminacy**", it became clear, more recently, that **complex systems** combine it with local or **microdeterminacy** in such a curious way as to generate a global **semideterminacy (chaos)**. And "**ideal-types**" and "**taxonomic constructs**" should be used as carefully, as any abstract **construct**.

1400

GENERAL SYSTEMS THEORY: Aims¹⁾

Ludwig von BERTALANFFY summarized as follows the aims of General Systems Theory:

"a) There is a general tendency towards **integration** in the various sciences: natural and social.

b) Such **integration** seems to be centered in a general theory of systems.

c) Such theory may be an important means for aiming at exact theory in the non-physical fields of science.

d) Developing unifying principles running "vertically" through the universes of the individual sciences, this theory brings us nearer to the goal of the unity of science.

e) This can lead to a much-needed **integration** in scientific education.

f) Bringing us closer to the unity of science and the **integration** of scientific education, this theory could provide a basis for a conceptual synthesis capable of fulfilling the time-honored, but presently unfulfilled functions of conceptual guidance and individual and collective motivation. (1956, p.2)".

Through paragraph b), it can be seen that the author – possibly because of an unfortunate translation from German – did not clearly distinguished General Systems Theory from a General Theory of Systems (not to speak of LE MOIGNE's "Théorie du **Système Général**"), which produced later on a great deal of confusion and much controversy. (See "G.S.T.: what does the expression mean ?").

He saw however clearly some conceptual traps that his successors did not always avoided. In D. Mc NEIL's words: "He recognized that a half-baked theory of systems would quickly degenerate into insubstantial platitudes and vapid truisms or be trivialized into mere technology (p.16, p.101). He counseled against purely academic theory, saying that "theory without practice is mere intellectual play" (p.101). He warned against the reification of **models**, e.g. confusing **game theory** with life or misrepresenting exercises as "**problems**" (p.22-3, p.101). He cautioned against accepting analogs and **analogies** as either the complete expression or the definitive proof of systemic theory (p.14, p.35) even if those **analogs** happened to be his own beloved differential equations. He told us not to misapply systemic attributes across **echelons of order**, e.g. to suppose that a **social system** is "living" because its constituents are (p.14). He warned us to eschew **reductionism**, e.g. to mechanical **models** in MKSA units, and to respect emergent irreducibility (p.14) and human **purpose** (p.79)".

D. Mc NEIL comments: "We can also take some advice from several errors which are implicit in von BERTALANFFY's own presentation. Technically, he perpetuates the confusion of "system" with "**structure**" by his emphasis upon formalism and **abstraction** without full acknowledgment of the "**control**" and especially the "**content**" aspects inherent in systems. Philosophically, he does not address the prospect that a rigidly unified systemic **paradigm** might emerge as a tyranny in its own right, imposing "one right way" of thinking that would be at least as harmful as any institutionalized monoculture of orthodox fragmentary sciences" (1993, p.19).

BERTALANFFY acknowledged A. LOTKA's priority (1925) as to the **concepts** of general systemic laws, in the guise of simultaneous differential equations for the definition of complex systems. He gave in his 1955 paper a number of interesting historical references. He was however apparently unaware of A. BOGDA-

NOV's 1922 work in which one can read this striking observation: "In technology and in science, nearly all of the greatest discoveries came from the transfer of **methods** beyond the limits of the **fields** in which they originated" (1980, p.24).

K. BOULDING in turn observed (in 1956) that: "In recent years increasing need has been felt for a body of systematic theoretical **constructs** which will discuss the general **relationships** of the empirical world. This the quest of General System Theory. It does not seek, of course, to establish a single, self-contained "general theory of practically everything" which will replace all the special theories of particular disciplines. Such a theory would be almost without **content**, for we always pay for generality by sacrificing **content**, and all we can say about practically everything is almost nothing. Somewhere however between the specific that has no **meaning** and the general that has no **content** there must be for each **purpose** and at each **level of abstraction** an optimum degree of generality... not always reached by the particular sciences" (1956, p.11).

According to E. LASZLO: "The promise of general systems theory consists in 1) discerning natural systems in diverse areas of investigation, i.e. identify those real **entities** which can be analyzed in terms of general systems laws; 2) providing an inventory of natural systems from atoms to **ecologies** and possibly to **social systems** and the world system; 3) formulating the general principles accounting for the **evolution** of systems on multiple **hierarchical levels**, crossing the **boundaries** of the inorganic-organic, the organic-multiorganic, and their many subdivisions; and 4) referring chosen problems of philosophic-scientific-humanistic interest to the systems analysis of the relevant **phenomena**, carried out in the **context** of the integrated scheme of **hierarchically organized** natural systems" (1974, p.19).

1401

GENERAL SYSTEMS THEORY and Cybernetics^{1) - 3)}

As observed quite early by L.von BERTALANFFY, General Systems Theory should not be confused with cybernetics in general. And still less so with WIENER's much more limited in scope first cybernetics, strictly related to **communication** and **control**. There has however been a growing connection between the two subjects, specially since W.R. ASHBY's "Introduction to Cybernetics" (1956) and M. MARUYAMA's "**Mutual causality**" as **pattern** generator (1963).

W. CANNON's **homeostasis** (1932) also is basically a cybernetic **concept**, while understandable only as a system's property. On the other hand, **positive feedbacks** tend to throw systems out of **dynamic equilibrium** and, as a result, they escape from the cybernetic **mech-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

anisms of **regulation** and **control**. Classical (i.e. **1st order**) **cybernetics** could thus be evaluated as the province of the **homeostatic systems**.

von FOERSTER **cybernetics of 2nd order** as well as PASK's cybernetics of **cognition** and **learning** and, later on, MATURANA's **autopoiesis**, while having their roots in cybernetics, are in fact systemic theories.

G. KLIR, in turn, describes as follows the innovations introduced by G.S.T:

"1. A new way of looking at the world has evolved in which individual **phenomena** are viewed as interrelated rather than isolated and **complexity** has become a subject of interest.

"2. Certain concepts, principles and **methods** have been shown not to depend on the specific nature of the **phenomenon** involved. These can be applied without any modification, in quite diverse areas of science, engineering, humanities and the arts, thus introducing links between classical disciplines and allowing the concepts, ideas, principles, **models** and **methods** developed in different disciplines to be shared.

"3. New possibilities (principles, **paradigms**, **methods**) for special disciplines have been discovered by making investigations on the general level." (1969, p.16).

In the first years of G.S.T. (and **cybernetics**), this was not so obvious. However, during the last twenty years, or so, the conceptual "tool-box" has grown apace, specially in the mathematical field: **Fuzzy logic**, **Theory of Catastrophes**, **Fractals**, **Percolation theory**; but also from other sources: **Dissipative structuration**, **Organizational closure**, **neural networks**, etc...

1402

GENERAL SYSTEMS THEORY: Epistemological evaluation^{1) - 3)}

M. BUNGE proposed an epistemological evaluation, not of "a" General System Theory, but of the different General Systems Theories in existence, as for example "... the statistical **theory of information**, **game theory**, **control theory**, **automata theory**, and even the general Lagrangian framework, the general classical theory of **fields**, and the general quantum theory of **fields** (misnamed "axiomatic field theory") (1977, p.32).

He considers that: "All of these theories are **phenomenological**, i.e. are **mechanism-free**... Hence, they can describe the **behavior** of certain systems but not explain how they work. Moreover they are **stuff-free** - i.e. they make no detailed assumptions concerning the nature of the **components** of the systems concerned. Whence their extreme generality" (Ibid).

As a result, G.S.T. have no specific predictive power, unless complemented with "extra **knowledge** concerning the composition" of the specific system under consideration.

BUNGE gives an example, inspired by the case of the **TURING Machines**, "which being equipped with infinitely long tapes, are strictly speaking unrealizable".

As a result, "... while **automata theory** is *applicable* (by specification) and moreover guides much of advanced engineering **design** and even some psychological research (SUPPE), it is *irrefutable*. It is not even confirmable in the traditional manner of predicting and checking: the theory makes no specific **predictions**, it prohibits hardly any **event**, and it suggests no experiments other than *Gedankenexperimente*" (i.e. Thought experiments as proposed by EINSTEIN) (Ibid).

In short, concludes BUNGE, G.S.T.s are "*empirically untestable*".

He admits however that they can be bettered: "In fact, G.S.T.s are *corrigible* if not exactly refutable in the light of empirical evidence. To begin with, they can be improved upon formally. i.e. logically or mathematically... Or they can be made more complex in an attempt to fit better their intend referents" (Ibid., p.33).

While not confirmable in traditional manner, they can be, according to BUNGE, confirmed *conceptually* and also *practically*. "Thus general **network theory** is confirmed conceptually by being shown to capture the traits common to all **nets**, whether physical or **informational**. And it is confirmed practically by being used in the **design of nets** of some kind" (Ibid., p.34).

Without being the following truly a **confirmation**, it should also be noted that **network models** make sense and can be used for acquiring a better **understanding** of some systems in which very numerous **elements** are connected in a semi-permanent and more or less probabilistic way, as for example **social systems**.

BUNGE states moreover that "G.S.T.s are so many frameworks that must be adjoined specific **models** of the system of interest before they can be of any use. For example, in the case of **information theory** we must be able to identify at least the **sources of information** and of **noise**, the **channel**, and the **receiver**; and we must have a **code** for the system of **signals**" (Ibid).

(Let us observe, by the way, that BUNGE, no doubt, speaks here of SHANNON's *communication theory*)

"In other words, a member of the G.S.T. **class** becomes a specific theory of the standard type, perhaps a scientific theory, when enriched with specific **information** concerning the system to which it is applied".

And "G.S.T.s are confirmed a) by fitting all families of specific theories (*conceptual confirmation*) and b) by helping in the building of specific theories that are tested the classical way (*indirect confirmation*)" (Ibid).

Finally: "G.S.T.s are *generic frameworks* helping one to think of entire genera of entities in a **variety of domains**, from biology and psychology through hardware and human engineering to city **planning** and politics. True G.S.T.s solve no particular problems without further ado - but on the other hand they help in the discovery and formulation of new problems and they clarify basic ideas in all fields of inquiry" (A. RAPOPORT, 1972, p.74 - as quoted by BUNGE).

1403

GENERAL SYSTEMS THEORY: History¹⁾

It could be said that there was a pre-history of systems theory, in which early isolated authors developed systemic and cybernetic concepts without being aware of each others and were forgotten or presumably unknown by the "founding fathers". Such are the cases of:

d'ARCY W. THOMPSON, whose fundamental work on "**Growth and Form**" (1916), reprinted in 1952, can be viewed as the first attempt to use **homomorphies** and **isomorphies** systemically.

A. LOTKA, whose "Elements of Mathematical Biology" (1924), reprinted in 1956, offer a synthesis of his original **concepts** about **growth**, **equilibrium**, general **evolution** and natural **cycles**.

A.A. BOGDANOV and his "Essays in **Tektology**", forerunner of cybernetics, first published in Russian in 1921 and translated only in 1980 to English.

J.C. SMUTS, the South African general and statesman, who published in 1926 his seminal essay on "**Holism and Evolution**", reprinted in 1973.

W. CANNON, who in his "Wisdom of the Body", probably inspired from Cl. BERNARD's concept of "milieu interne", formally introduced in 1932 the concept of **homeostasis** in biology.

Another milestone was the solution of the **MAXWELL's demon** paradox by L. SZILARD in 1929, who showed the fallacy of the supposed possibility to do some work without any **source of energy**.

Still other precursors were S. ODOBLEJA, with his "Cybernetic Consonantist Psychology" (1938) and P. VENDRYES with his theory of **regulations** and **autonomy** (1942).

J.van GIGCH resumes the early history of G.S.T. as follows: "General Systems Theory did not originate with just a handful of thinkers. Several currents were present at its inception. Concepts connected with **open systems** were developed concurrently in **thermodynamics** and biology in the 1930s" (1978, p.58).

From 1929 on L.von BERTALANFFY and J.H. WOODGER proposed the basic **concepts** of organismic biology, that were to lead BERTALANFFY to the first definite formulation of a General Systems Theory in 1950. (See bibliography in L.von BERTALANFFY (1949 & 1950).

van GIGCH pursues: "**Equifinality** was introduced by von BERTALANFFY in 1940. The contrast between inanimate and living nature was described by BRILLOUIN in 1949. Examples of **open systems** in ecology, neurological systems and philosophy were made evident in the 1950s in publications by WHITACKER, KRECH and BENTLEY respectively.

"General Systems Theory is the result of other fundamental contributions such as those of:

"1. John von NEUMANN (1948), who developed a General Theory of **Automata** and laid the foundations of **Artificial Intelligence**.

"2. C.E. SHANNON's work in **Information Theory** (1948), by which the **concept** of amount of **information** was developed around **Communications Theory**.

"3. Norbert WIENER'S **Cybernetics** (1948), by which the **concepts** of **entropy**, **disorder**, amount of **information** and **uncertainty** were related to each other and their importance emphasized in the **context** of systems.

"4. W. Ross ASHBY (1956)... developed the **concepts** of **Cybernetics**, **self-regulation**, and **self-direction** around the ideas originally conceived by WIENER and SHANNON" (p.58-9).

van GIGCH also traces sources outside **thermodynamics**, **biology** and **cybernetics**:

"KOEHLER represents the early attempts to state the manner in which systems properties regulate the **behavior** of the **components** and, hence, the **behavior** of the system.

"REDFIELD ... brings out both the **continuity** and the great **variety** and **complexity** of the transitional bridging the biological and socio-cultural **levels**" (p.59).

Still other important precursors were:

B. RUSSELL and A.N. WHITEHEAD whose **theory of logical types** cleared the way for a better theory of the **observer** and for **constructivism**.

KOEHLER, KOFFKA and others represent the contribution of **Gestalt** psychology.

A. ANGIAL, as early as 1941, formulated very clearly the basics of a "logic of systems" (1969, p.17-29).

E.A. SINGER's studies about **mechanicism**, **vitalism** and **naturalism** (1946) were influential on C. WEST CHURCHMAN, R.L. ACKOFF, J.van GIGCH and others.

A detailed history of Systemics and Cybernetics does not yet exist and would be a timely contribution to the history of 20th century's science and philosophy of science.

1404

GENERAL SYSTEMS THEORY (Innovations introduced by the)¹⁾

According to J.van GIGCH: "General Systems Theory meets the objections raised against the analytic-mechanistic approaches and accomplishes the following:

"1. It takes a **holistic** approach to systems by preserving their **identity** and the properties of irreducible units.

"2. It raises the generality of particular laws by finding **similarities** of **structure** (**isomorphisms**) across systems, regardless of disciplines and the particular science in which they are found.

"3. It encourages the use of mathematical **models**, which offer a **language** devoid of **content** but which can, by their generality, suggest **analogies** or lack of **analogies** among systems... The limits of this approach is the lack of faithfulness of the mathematical **models** to the realities of the systems.

"4. It promotes the unity of science by providing a "framework of **coherence** for the organization of **knowledge**" (RAPOPORT). It can act as a "system of systems" to point to gaps in special fields and to **similarities** across disciplines (BOULDING)" (1978, p.48-9).

van GIGCH developments on these points are of great interest.(1978, p.55-75).

1405

GENERAL SYSTEMS THEORY: limits to its algorithmization^{2) - 3)}

N. KASKOV, quoted by I.V. BLAUBERG et al, "demonstrated that the following mass problems could not be solved in the framework of the general systems theory: - to construct

- an **algorithm** allowing to find all the **elements** of any given system;
- an **algorithm** allowing to find all the **connections** of any given system;
- an **algorithm** allowing to determine the **structure** of any given system;
- an **algorithm** allowing to determine all the **functions** realized by any given system" (1977, p.205).

Of course, neither could any other theory produce any such **algorithms**.

Such a result seems perfectly logical, in view of the massive **non-linearity** of **complex systems**. KASKOV's statements are quite interesting in relation to FORRESTER's **Systems Dynamics** and to **Systems Analysis** in general.

→ **Petri networks**

1406

GENERAL SYSTEMS THEORY: Mathematical aspects^{1) - 2)}

A. RAPOPORT sees G.S.T.: "as an effort to fuse the **mechanistic** and the **organismic** approaches so as to utilize the advantages of each. A system is not merely a totality of units (particles, individuals), each governed by laws of **causality** operating upon it, but rather a totality of **relations** among such of these units. The emphasis is on organized **complexity**, i.e.,

on the circumstance that the **addition** of a new **entity** introduces not only the **relation** of this **entity** to all others but also modifies the **relations** among all the other **entities**" (1966, p.5).

As a result, as stated in the same paper by RAPOPORT, the mathematics of the simple **linear causal relations** is not anymore useful, and may even become quite misleading. Fortunately, during the last 30 years a number of new (or renewed) mathematical formalisms did emerge:

- expanded **graph theory**
- **catastrophe** theory
- **fuzzy sets**
- **fractals**
- **deterministic chaos**

... all of which offer new insights into dynamic **behavior** in **networks** of **interdependent elements**.

M. MESAROVIC gives the following syntactic definition of a general system: "A general system is defined by:

1. A **set** of implicitly defined formal **objects**
2. A **set** of elementary **transformations** *T*
3. A **set** of **rules** *P* for forming the sequences of *T*
4. A **set** of statements indicating initial forms of the formal **objects** for use in generating new forms of the **objects**" (1964, p.7).

This definition seems too deterministic in view of more recent developments.

1407

GENERAL SYSTEMS THEORY: Some axioms (C.W. CHURCHMAN) (1963)^{1) - 3)}

According to CHURCHMAN: "The intent of the axioms is to state two things:

- 1) that systems are complexes that can be designed and evaluated, and
- 2) that the adjective "general" in the phrase "general systems theory" modifies systems, as well as theory" (1963, p.173).

Hereafter, the nine axioms of CHURCHMAN are given:

"1. Systems are designed and developed" This statement implies that systems are man-designed, which seems seriously restrict and one would say, unduly so, the possible uses of systemic **models**, as applied to various kinds of **non designed concrete systems**.

"2. Systems are **component** designed". Confirming the first axiom, CHURCHMAN states: "The designer conceives a **design** as consisting of a **set** of subproblems, the solution to each subproblem leading to a **component** of the larger system"(ibid).

"3. The **components** of systems are also systems". This could be called the "matrioshka postulate". However, just as the "matrioshka"(or **fractals**!), it should end somewhere and somehow.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"4. A system is closed if its **evaluation** does not depend on the **design** of its **environment** within a specific **class** of **environments**". Being this a tall order, CHURCHMAN adds: "Usually the designer does not attempt to account for all possible **environmental changes**. If he does, then we have the following:

"5. A General system is a system that is closed and ... remains closed for all possible **environments**". We obviously pass here from the **model** based on a concrete **situation** to a totally abstract one."

CHURCHMAN'S four last axioms are avowedly philosophical and most generally debatable:

"6. There exists one and only one general system (Monism)".

"7. The general system is optimal (optimism)"(!) CHURCHMAN states thereafter the following quite idealistic belief: "The most general task of system **design** is to approximate a general system".

"8. General system theory is the **methodology** of searching for the general system".

This statement should be compared with BLAUBERG's et al opinions about General Systems as theory or **methodology**.

"9. The search becomes more difficult with time and is never completed (realism)".

1408

GENERAL SYSTEMS "THEORY": Theory or methodology ? ^{1) - 3)}

If the **concept** of "General Systems" is needing a clear scientific status, it would seem that no definitive agreement has yet been reached in this sense.

In 1977, I. BLAUBERG et al wrote: "Neither BERTALANFFY's conception nor, incidentally, the subsequent evolution of research in the general system theory has been able to resolve the dilemma "a scientific and technological theory or a **methodology**". Inasmuch as everything investigated in science may be represented as **sets** of interconnected **elements**, the system **concept** has a universal significance, while attempts at constructing a universal scientific and technological systems theory will probably be reduced to truisms" (1977, p.193).

... and "...the general system theory as a **methodology** of investigating system **objects**: 1) is deprived of the status of a scientific theory, and 2) can be developed successfully only in the presence of systematically formulated and sufficiently rich systems theories and under the conditions of constructing a specific methodological **language** and the conceptual apparatus of research" (Ibid).

One basic difficulty seems to be rooted in the limits given to the significance of the system **concept**. It does not appear to be true that "everything investigated in science may be represented as **sets** of interconnected **elements**", or at least, not all **interconnexions** are **complex**.

There are different types of concrete systemic **situations** or systems, as for example, **composite**, **autopoietic**, **isolated**, **open-closed**, etc... for which we need different **models**. However *all* of these **models** have some common characteristics: a complex **structure** in **space** and **time**, **non-linearity** and **regulations**, a permanent identity.

On the other hand, during the last twenty-plus years a growing number of specifically systemic descriptive instruments did appear: **systems dynamics**, **reconstructability analysis**, **catastrophe theory**, **fuzzy sets**, **fractals**, **percolation**, **deterministic chaos**... which can be considered as a "tools box" of **models**.

One wonders if BLAUBERG et al would still maintain their opinion today (2004). It seems indeed that we are well on our way toward a general system theory (i.e. a general theory of **complex systems**) and methodology (having and using specific new **models** for the study and **management** of complex **situations**).

1409

GENERAL SYSTEMS THEORY: What does the expression mean ³⁾

R. RODRIGUEZ DELGADO writes: "According to BERTALANFFY "General Systems Theory" is a new science of **organization** and **wholeness**. He postulates the legitimacy of seeking a theory, embracing universal principles, valid for "systems" in general.

"One of its main consequences is the detection of structural **similarities** or **isomorphisms** in different fields as for example the exponential law of **growth**, the theory of non-organized or organized **complexity** or the general theory of **organization**.

"The classical science tried to explain **phenomena** by isolated causal chains or by statistical results due to **randomness**. However this science is not sufficient for the understanding of the **interactions** of a great number of **elements** or **processes**, which demands new types of mathematical and logical thought, to be added to those already in existence.

"This germinating thinking has been enriched and encompasses now the **information** and **communication theories**, **cybernetics**, **net theories**, stochastic **models**, **bifurcations** theory, **multicausality**, **uncertainty** and **complementarity** principles, **order** and **chaos theories**, etc.

"Generally, the authors do not speak about a "General Theory of the System", which would concord with BERTALANFFY's thinking, but of "General Systems Theory"... a way of speaking

which, as observed by CHURCHMAN, is ambiguous in English, in view that the adjective "General" may be applied to "systems" as well as to "theory". As a result "General Systems Theory" could mean a "Theory of General Systems" or a "General Theory of Systems".

"This **ambiguity** could be removed by considering that the "General Theory" includes two different **levels** of generality, just like "Philosophy", which means a global thinking, while it can be simultaneously divided into "Philosophy of science, of fine arts, of law, and even admit new subdivisions as Philosophy of physics, of biology, of painting or of music.

"It is thus convenient to consider General Systems Theory as applicable at any kind of **levels** and any type of systems – natural, human or artificial – even of very reduced size, in view that its characteristics are of universal scope.

"On the other hand, the Theory of the General Systems would include large subdivisions: physico-chemical, biological, social, human, artistic, axiological, ideological systems, etc., which would research the general laws and the emergent qualities of each group, aside from including **interdisciplinary fields** as for example physico-chemistry or molecular biology.

"A study of **emergent** qualities on each **level** gives us a **synchronic** vision (through which systems appear in a clearly differentiated way), as well as a **diachronic** one, (in which it becomes possible to conceive the **evolution** and the mutations of physico-chemical, biological, social, ideological systems, or even of **machines**.

"Of course, so-called "basic **concepts**" are not unshakable principles, but on the contrary concepts that should be considered, elaborated and debated from very diverse angles" (1993a, p. 215-6).

This is a good general summary of the varied approaches of many systemists toward this **epistemological** and **semantic** issue.

1410

GENERAL THEORY OF SYSTEMS ^{1) - 3)}

R. RODRIGUEZ DELGADO, in accordance with his critique of General Systems terminology, proposes this expression and comments: "The General Theory would deal with generalizations applicable to all kinds of systems: conceptual, natural, technological, etc. It would contain also general principles and laws based on rational thinking.

The **boundaries** of a General Theory of Systems would be **fuzzy**, bridging Philosophy with the **General Theory of Systems**. Its curricular content should be clearly established by experts in General Systems Theory.

"A General Theory of Systems should be closely interrelated to a Theory of **Knowledge**, based also on rational and intuitive approaches. A rational **method** means an approach based

in sciences and, specifically in experimental science. Its complement would be a set of intuitions transformed into logical speculations in domains not reachable by reason. We know **knowledge** with our **knowledge**, and this has an *inescapable tautological bias* where reason and intuition met, integrated by intelligence" (1989, p.21).

R. VALLÉE emits a coincidental opinion, arguing that, in 1945, BERTALANFFY introduced his concept in German as "allgemeine Systemlehre" that could be translated as "General science of systems", or "General Systemics" (1991b, p.33).

D. McNEIL holds similar views: "... a general theory of systems must not only be a theory about systems per se but also about how systems are constituted, developed and perceived" (1993a). This author enounces the following program conducive to these aims, and which should include:

"A clear, constructive definition of its subject matter, especially of *system*;

"A succinct, constitutive core of central concepts, expressed at a uniform level of discourse, which are common to every system;

"A conceptual space into which its concepts can be defined and mapped together with a principled way of connecting concepts to one another, within and across **levels** of discourse and **echelons of order**;

"A meta-systemic way to apply the theory transitively to any system and reflexively to itself;

"An orderly way to accomodate the **voluntary mutuality** between the subject, i.e., systems, and the percipients, i.e., humans;

"A method for the ethical application of systemic theory to wholesome life for people and their habitats" (1993, a).

From another viewpoint, in his comparison with other ways to define systems theories in general, L. TRONCALE writes that it requires: "... very broad comparisons across many different **scales** of systems and across many different conventional disciplines; leads to very abstract and qualitative **descriptions** (not properly called **models**) of generalized systems **functions** such as systems **stability**, **structure**, **function**, origins, **development**, **evolution**, **emergence** and **decay**; by emphasizing systems-level **functions** it desemphasizes **component** specific differences of the multitude of disciplinary systems being compared; results are fully **context-independent**; uses the full set of **isomorphies**. However, the lack of quantification leads to much reduced predictive power as regards specifics in favor of broad-scale form..." (1985, p.45).

For M. BUNGE: "The general theory of systems is a *hypergeneral* theory, for dealing with systems of all kinds. And what we have called

generic systems theories deal with entire genera of systems, such as physical, chemical, biological, or social systems" (1993, p.220).

According to BUNGE, "the general theory of properties and the relational theory of space-time" are hypergeneral theories. A relativistic theory of **simultaneity**, or **fractal** theory, would enter in this **class**".

On the other hand "... the general theory of social systems, ... **automata** theory, **information theory**, general **control** theory,... **decision theory** and **game theory**" would be generic systems theories (Ibid).

J.van GIGCH's opinion is more or less, but not completely, in line with BUNGE's understanding: "As LASZLO has clearly pointed out, we should refer to *general system theories* and not to *general systems theory*. The plural should apply to theory and not to system, in that we can conceive of many theories in the field. On the other hand, there is no such thing as a general system and entities called *general systems*. We have also grown accustomed to associating the adjective "general" with "system" in the forms *general system* and *general systems*, instead of associating "general" with "theory" (1978, p.60).

van GIGCH recognizes that he himself "has fallen into this trap by naming this book *Applied General Systems Theory*" (Ibid.).

For an opposite view, based of J.L.LE MOIGNE's work see "**Système Général (Theory of the)**".

This compiler agrees with LASZLO's view, but this historical confusion is now so deeply rooted that it is probably impossible to remedy it.

→ **Volution**

1411

GENERAL THEORY OF SYSTEMS: Performance criteria ¹⁾

L. TRONCALE, who also prefers to speak of General Theory of Systems instead of **General Systems Theory**, proposes the following criteria for its satisfactory use: "It would:

- consist of precisely defined concepts
- be **context-independent**, **invariant** across all **scales of magnitude**, demonstrable in all disciplines
- require the use of the full **set** of **isomorphies**, that is the minimal, sufficient, and necessary **set** (probably large)
- require many specific **linkages** between **isomorphies**
- unobservable in one discipline
- unverifiable, unfalsifiable, even unrefinable, in one or a few disciplines
- apply to both descriptonal and operational views
- describe both **continuous** and **discrete** systems
- be limited in its range of application only by the current state of applied **knowledge**

- possess built-in **rules** for desabstraction, **scale translation protocols**, or correspondence principles
- possess a built-in operational **taxonomy**
- have **isomorphies** and **linkages** that were self-organizing" (1985, p.79).

Most of these conditions do already exist, but merely in an implicit way. It should be the responsibility of every systemist to understand and apply them in order to avoid the very nullification of systemic thinking and of its practical use as a global scientific **methodology**.

1412

GENERALISM ¹⁾

The scientific and methodological viewpoint that centers our attention upon global, complex and interactive **situations** and seeks to reintroduce some general **coherence** within scientific **knowledge**.

L. LÖFGREN quotes the following comment from R. ROSEN: "Such a unification, with the resultant economy of thought, seems absolutely necessary in these days of explosive **growth** in scientific **knowledge**, if the student is not to be hopelessly submerged under the torrent of specific but specialized investigations relevant to his interests. Indeed, unless expanding **knowledge** is accompanied by corresponding conceptual economies, a comprehensive **understanding** of even a small corner of science may become impossible before much longer" (ROSEN, 1970, in LÖFGREN, 1974, p.78).

1413

GENERALIST (Role of the) ^{1) - 4)}

Already in 1955, L.von BERTALANFFY quoted a number of authors who, in 1949, emphasized the necessity to count with generalists and defined their role as follows: "Any research group needs a generalist, whether it is an institutional group in a university or a foundation, or an industrial group. In an engineering group, the generalist would naturally be concerned with system problems. These problems arise whenever **parts** are made into a balanced **whole**" (H. BODE et al, 1949).

R. RODRIGUEZ DELGADO states: "The intervention of generalists is necessary, specially in the first orientation stage. They do not need to be "teachers" in the common sense of the word, but "resource persons" that could advice about the materials in which systemic **concepts** are better expressed, explain difficult subjects, and act as "conciliators" trying to find **complementarity** in **concepts** apparently opposed. They should try to unveil the causes of "real" **conflicts** of interests and ideas... It is

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

convenient to train the learners for finding, by themselves common **sets** of interlinked general concepts related to natural and human sciences, demonstrating their unity and diversity" (1990, p.8).

A generalist is also normally specialized in some field. But he should have a good overall **understanding** of the various disciplines referring to aspects influencing the **whole** to which his/her research is centered (or influencing the significant **environment** of this **whole**). In order to obtain such a reference viewpoint, the generalist needs a **language** of second order or **meta-models** giving her/him the potential to understand **concepts** and **models** used in other disciplines.

The numerous global man-made disasters which occurred before and since the emergence of systemics fully justify these views, which are also applicable to the satisfactory operation of economic, social and political institutions as well as to their complex **interrelations**.

1414

GENERALIZATION^{1) - 3)}

The derivation of a more embracing law, principle, or **method** from a number of specific cases of some **phenomena** or **situations**.

Generalization involves the discovery of some common characteristics, **forms** or **patterns** present into the different **situations** considered. It consists in looking for **homomorphisms** and, if possible for **isomorphic models**, and constructing useful **heuristics**.

However, generalization is antinomic to more precise **distinctions** between the compared **elements**. It should be used carefully.

1415

GENERALIZATION GRADIENT¹⁾

A differential measure in **space** and **time** of the real possibilities to extend the validity of some **model**.

This **concept** has been introduced by M. TODA (1976, p.84). Obviously, unsound generalizations or extrapolations may lead to inadequate results.

However, any practical measure of a generalization gradient seems a quite difficult proposal. Even so, the problem cannot simply be by-passed.

Fuzzy sets theory could possibly be helpful here.

1416

GENERALIZATION (Over-)³⁾

Over-generalization is in many cases the result of excessive enthusiasm with generalization, when its power is recently discovered. M. BODEN observes for example that young children learning the **rules** of verbs tenses start treating

irregular verbs in the same way than regular ones, only to correct this unwarranted generalization later on (1990, p.125).

However, this kind of self-adjusting **mechanism** does not always function correctly and pathological **situations** may arise, as shown for example by A. KORZYBSKI (1950).

Unfortunately, over-generalization seems to breed conceptual short-sightedness, **semantic** muddles, wrong appreciation of **situations** and even twisted or intolerant **behavior**.

1417

GENERATIVE^{1) - 3)}

The general characteristic of any device, **set** of **rule** or set of **production rules** that allows for, or produce a number of useful or significant **combinations**, while excluding others.

Languages, for instance, have a generative **transformation grammar**, defining the ways to form well constructed sentences, using correct words, formed by a reduced number of specific phonemes. In this case, the **hierarchical** nature of the generative system is quite clear.

The various branches of mathematics, as for example arithmetic, geometry, analysis or **topology**, have each a generative system, defining precise **rules** for the construction and **transformations** of their objects of study.

Chess **rules**, harmony **rules** in music, or the generative system of concepts in organic chemistry, produce in the same way **conceptual spaces** to be explored.

Even a culture can be seen as a generative system.

K. KRIPPENDORFF observes: "The use of ... generative devices is **constructivism's** alternative to testing verbal hypotheses and theories with available data" (1986, p.33).

→ **Algorithm; Congruence; Constraint; Creativity; Heuristics and Rule**

1418

GENERATIVE PROCESS

→ **Process Theory**

1419

GENERIC DESIGN SCIENCE¹⁾

The global science of design.

J. WARFIELD states: "Generic Design Science is the whole of design science. It is comprised of all the specific design sciences and the Generic Design Science (itself), serving the universe of design activity. At the present times this concept remains unrealized" (1994, p.20).

The following is a summary by WARFIELD on G.D.S.:

"Generic design refers to the development of outcomes that necessarily are present in the design of anything. Specific design refers to the development of outcomes that necessarily are present for a single design, or for members of a small **class** of designs.

"When design aims to resolve **complexity**, the generic outcomes may often affect thousand or millions of people; hence the route to their development should be based in a science that is responsive to the demands of **complexity**."

"Generic design is such a science. It incorporates the foundational, theoretical and methodological **components** that any science ought to exhibit (if only for purposes of facilitating its **integration** with other sciences, when **aggregation** is needed to serve application)..."

"Because it offers transparency, and evaluative **criteria**, it is well positioned for **assessment** and improvement. Because it offers Laws of Design, it gives focus to **constraints** that will, if allowed to do so, degrade design activity, and lead to disasters" (1995e, p.8).

Generic Design considers the ways designers do design as related to psychological and conceptual aspects, as well as the difficulties proper to design in the general and in specific cases. It adds new dimensions to design and contributes to the **management of complexity**.

1420

GENERIC PLANNING^{1) - 4)}

→ **PLANNING (Generic)**

1421

GENETIC ALGORITHM

→ **Algorithm (Genetic)**

1422

GENETIC PROGRAM OR DEVELOPMENTAL DYNAMICS?

The recently completed sequencing of the human genome introduces again the possibility of a exclusively **reductionist** view of life: looking for ex. for the "gene of schizophrenia". In the extreme view, the gene becomes "the atom of the biologist".

However, in a review of E. FOX KELLER's book "The Century of the Gene"(2000), H. J. RHEINBERGER observes that FOX KELLER "goes so far as to question the very possibility of compressing development into a meaningful **algorithm**"(2001, p. 65)

In his view "the dynamics of **development** and **evolution** will call for an integrated **understanding** of the **organism** as a **whole** and will not be crudely reduced to genetic **mechanisms**"(p. 66) and that "gene technology may well be, indeed must be regarded as an obligatory passage point on the way to a more systemic view of how organisms work, develop and evolve"(p. 66)

We should be attentive in FOX-KELLER view as quoted by RHEINBERGER to the "complexity of the regulatory **dynamics**" that mediate between genetic constitution and bodily performance", lest "the term gene...may even have be-

come, as W. GELBART has suggested, a "hindrance to the understanding of biologists" and perhaps even more of a hindrance to the understanding of lay readers" (p. 66)

Genes are basically **elements**. As such, that can have **position values** and become dynamically associated in **organization process**. It would thus be apt to speak of "developmental **dynamics**-a field quite widely open to further research- better than of "genetic program" (Sh. PENMAN, 2001, p. 66-67)

1423

GENOME and PHENOME⁵⁾

In **living systems**, respectively the inherited potentialities, and the properties acquired during development.

M. BUNGE writes: "... while every organism inherits its genome, it evolves its own phenome in a given **environment**; the phenome depends then upon both the genome and the **environment**" (1979, p.101).

This defines a very general **set** of properties. It would be interesting to consider possible corresponding aspects in enterprises, institutions and other **sociosystems**.

1424

GENOTYPE⁵⁾

The **set** of an **organism's** characters acquired through heredity.

The genotype should be clearly distinguished from the phenotype, as observed by K. KRIPPENDORFF: "The **distinction** is important because it is the genotype, not the phenotype, which is reproduced, but it is the phenotype, not the genotype on which natural **selection** acts" (1986, p.33).

This implies that **autopoiesis** is basically a character of the individual.

→ **Disasters**

1425

GEOGRAPHICAL INFORMATION SYSTEM²⁾⁵⁾

"A **method** of managing computerised **data sets** as different as human **populations**, soil types, tree cover or roads, all referenced to the coordinates of a **map**" (D. MacKENZIE, 1998, p.57).

Such a system is presently installed in the Indian state of Maharashtra. Its objective is to reveal the probable consequences of any possible natural disaster in the making, in order to be able to take in due time protective **action**.

Such a global **information** system is very **cost-effective** when compared with the colossal losses incurred when calamities strike unprepared human groups.

1426

GEOMETRY (Fractal)

→ **Fractal Geometry**

1427

GEOSPHERE

→ **Lithosphere**

1428

GESTALT^{1) - 3) - 5)}

Any **configuration** perceived as a **whole**, with global properties that cannot be assigned to any specific **part**.

Gestalt is a German word meaning **form**, figure or shape, all properties of **wholes**. As such it is one of the main roots of systemic concepts and **models** and of so-called **holism**.

G. PASK offers the following definition: "Some property - such as roundness - common to a **set** of sense **data** and appreciated by **organisms** or **artifacts**" (1961, p.115). This definition emphasizes the perceptual significance but does not elaborate on the proper characteristics of Gestalt.

R.W. FULLER and P. PUTNAM complete somewhat the **concept** in the following way: "The concept of Gestalt has at its core the compounding of a **set** of elementary motor possibilities focussed to a **choice** of specific **act**" (1967, p.105). It results of the **stabilization** of the **relative dominance** of some **perception** cohered through an at least provisionally completed **random search process**.

D. KATZ, quoted by A. LOPEZ GARCIA and M. PRUÑONOSA, summarized a **set** of laws of **form** (not to be confused with G. SPENCER BROWN's **Laws of Form**), as follows:

a. "**Closure law**: lines which close a **space** and which are therefore correlative, tend to be put together...

b. "**Equality law**: if several active **elements** are present, then there is a tendency to put together those pertaining to the same **class**.

c. "**Proximity law**: the union of **parts** which constitute a whole tends toward a minimal interval of **time** or place. Factors b) and c) are correlative as pointed out by KOFFKA (1935, p.164): "... two **parts** in the **field** will attract each other according to their degree of **proximity** and equality".

d. "**Good shape law**: those **parts** of a figure which share the direction or the movement of the **whole** are put together" (1993, p.1197).

These authors translate these four laws to **linguistics** as:

a. an additive **relationship**
b. an equivalence **relationship**
c. a consecutive **relationship**
d. an inclusive **relationship**... between **language elements**.

E. ANDREEWSKY enumerates some "of the most powerful systemic concepts" which originated in Gestalt concepts:

"**Whole and parts**: A great deal of experiments involved with the factors of **perception**, have put forward the very general idea that the

characteristics of the **whole** determine those of its **parts**. These **parts** lose their individuality in the **whole** unless their own properties destroy the unity of this **whole**.

"**Figure-background**: Figures are always connected to their **context**, that is the **background**... This is reflected by a number of **pattern** recognition **phenomena**, namely optical illusions" (1993, p.186).

More generally, we could speak of perceptive illusions or ambiguities (touch, hearing and other sensorial ones).

ANDREEWSKY pursues:

"**Permanence of forms properties**: certain aspects of **perception** demonstrate quite clearly the relative independence of **pattern** recognition from the conditions of **stimulation**" (p.186).

She concludes: "It is thus possible to see in Gestalt Psychology the origin to some key Systems Science concepts, such as the relation between a system and its **elements**, or the status of cognition in the **observer-observed relationship**" (Ibid).

1429

GESTALT (Dynamic)¹⁾³⁾

"A **frame of reference** that allows for **creativity** within understood **parameters**" (R. NUMMELA CAINE & G. CAINE, 1994, p.119)

These authors state that - in **knowledge** acquisition - dynamic gestalts "... contribute to a sense of **wholeness** and, at the same time, contain and permit **flexibility**, **change** and excitement".

And "These larger plots, **belief** systems and agreements are dynamic gestalts because they provide overall **patterns** that make sense. These **patterns** tie together bits and pieces of **information** and give a cohesive **meaning** and **purpose** to our daily **learning**" (1994, p.119)

Of course, dynamic gestalts imply **time binding**. (See also hereafter)

1430

GESTALT QUALITIES^{1) - 2)}

"Perceptive **structures** relating to the object perceived as a **whole**...and not deductible from the properties of the **elements** of the **object**" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.224).

The authors give as examples the **structure** of chords in music, the **structure** of melodies which is preserved intact in transposition, i.e. in changing the key. They add the following comment "...This discovery has a clear methodological significance, since it provided experimental evidence for the fundamental inadequacy of the elementalist approach even to relatively simple psychic **functions** such as **perception**" (p.234).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Perceptive Gestalten were discovered in 1890 by Ch.von EHRENFELS and taken as the base for their Gestalt psychology by M. WERTHEIMER (1923), W. KOHLER (1929) and K. KOFFKA (1935).

For a balanced critique of the Gestalt psychology, see BLAUBERG et al. (p.225-6).

The simple **lineal cause-effect analysis** is also useless to reveal global Gestalten. J.von UEXKÜLL already observed in 1928 that any Gestalt unavoidably is a result of some "Gestalt building" **process** ("Gestalt-gebend") (1928, p.183).

He clearly distinguished the spatial from the temporal dimension of the Gestalt, which makes him a forerunner of the most acute **structuralists** (p.252).

It is of paramount importance to understand Gestalten as results of our perceptive **organization**, which may be, or not, a truthful reflection of reality. In some cases, reality as perceived is a result of a specific Gestalt **shift**, as for example with the NECKER cube, that admits two different but mutually exclusive visual perceptions. Gestalten are, in any case, corner stones of the systemic viewpoint on **perception** by **observers**.

→ **Figure ground**

1431

GESTALT SHIFT ¹⁾⁵⁾

The visual perceptive jump that permits viewing in alternance two different figures within an unique ambiguous figure.

This effect can be registered for example viewing the **figure-ground** figure represented to illustrate the corresponding article.

The mutual exclusiveness of both figures shows that the **ambiguity** is in our **perception**

1432

GESTALT (TEMPORAL) ^{1) - 2)}

According to J.W. SUTHERLAND, "... the **complex system** tends to become a *temporal gestalt*, carrying on interchange with other temporal gestalts within a **field** which, itself, must be defined and treated as a gestalt rather than a **mechanism**" (1973, p.38).

This is a somewhat overstretched extension of the gestalt concepts. However, it is obvious that our **perception** of **time** depends largely upon our permanently renewed **observation** of *different* more or less stable entities, which undergo **transformations** of *different* kinds at *different* rates.

1433

GLEICHSCHALTUNG

→ **Preferences (Collective)**

1434

GLOBAL AND LOCAL ¹⁾⁴⁾

G.L. FARRE makes the following important point: "The *global* and the *local*: the first is purely conceptual, while the second is ultimately sensorial" (2000, p. 245)

He adds: "**Observation** is a mix of the two, the former being projected onto the other. There is no case where the one is got without the other in the context of the sciences of nature" (ibid)

This is significant in various way:

- the global view is always constructed. It is in fact a constructed **frame of reference**. It is thus always subject to reform and **falsifiable** in Popper's meaning
- this applies to the hypothetical general "theory of everything" as well as to the current theories about so-called **globalization** in human affairs (ecology, economy, social conditions, **cultures**)
- as different people may have quite different **mind frames**, both the global and the local view should be viewed as relative, avoiding definitive unilateral and exclusivist stances. Even the scientific history of the 19th and 20th centuries shows as much.

1435

GLOBAL VIEW ^{1) - 3)}

A satisfactory global view of a **situation** or system should take care of the following aspects:

- All the significant **elements** or **components** must be identified;
- All their important **interrelations** must be recognized;
- No spurious or fictitious **interrelations** should be introduced;
- The real **dynamics** of the various **subsystems** should be clearly characterized (i.e. **linear or nonlinear; continuous or discontinuous; cyclical** or irregular, etc.);
- The basic **interrelations** of the system with its significant **environment** must be stated;
- No imprudent or unfounded **extrapolations** should be made.

These various **rules** are qualified ("significant", "important", "spurious", "real", "basic", "imprudent", "unfounded").

This introduces the **observer's** view and implies the need for **criteria**. Moreover, such **criteria** must necessarily be:

1. based on systemic and **cybernetic models** of the **interrelations**, suitable to maintain the unity, identity and **coherence** in the representative **global model**;
2. take in account the aims of the study and the **level of observation** used.

Obviously, no valuable global view could be obtained without the collaboration and mutual **understanding** between numerous specialists through a **transdisciplinary language**.

1436

GLOBALIZATION ¹⁾⁴⁾

A **process** of **association** among different systems formerly independent from each others.

Any globalization **process** implies the following conditions:

- the different systems must become in more or less permanent contact. Such a **situation** may occur for example when systems in expansion compete for the same **resources** of **energy, matter** or **information**.
- a new **communication network** should appear among the systems, according to the new **interactions** among them.
- some **meta-regulations** or **meta-controls** should become established, subordinating the different **decisions** systems to a set of general **rules** specific to the general needs of all the interconnecting systems.

Any globalization **process** leads to a deep internal reorganization of the systems integrated into the new **whole**.

Some former **subsystems** may disappear (a recent case is the replacement of the national currencies in the European Union by the Euro). Some former **parts** of the **integrated systems** may even recover some **autonomy** in specific matters. As written by the French politologist B.de JOUVENEL many years ago: "National powers are becoming too small to handle global **issues** and are too big to manage local ones" (1974).

Also D. BELL made similar comments.

1437

GLUE ¹⁾⁴⁾

A general **metaphor** covering "a range of related verbs such as adhere, attach, bind, bond, cohere, combine, connect, fuse, join, liase, link, paste, tie and weld" (R. Paton, 1999, p. 153)

These verbs describe various types of **interrelations** in more or less integrated or loose systems.

All describe **processes** with their corresponding **flows** of materials and **informations**.

"Glue" is apt as a metaphor because while the flows among **elements** are either permanent or intermittent, or **recursive**, they imply specific **interactions**.

Strongly organized systems are those very strongly "glued", as for example living beings wherein the **parts** cannot remain functional in their own way when cut out of the system.

Social systems or computer **networks**, for instance, are less strongly "glued" as their parts can somehow maintain their own functionality when separated.

In this paper Paton describes a variety of glues corresponding to different **contexts** and **functions**. He explores the relations of the concept with those of **pattern**, **limit** and co-limit and its more general meaning in **categorical** terms.

He also observes that glue relations can be **binary** or multiple in relation to a single element. There may thus be distinct modes of adhesion, attachment, etc.

(This is already clear at the chemical level for instance)

1438

GOAL¹⁾

"Some end **state** to which a system tends by virtue of its **structural organization**" (A. RAPOPORT, 1966, p.8).

A goal is generally understood as the **purpose** toward which an endeavor is directed, or an objective. R.L. ACKOFF for example states: "The goal of a **purposeful system** in a particular **situation** is a preferred outcome that can be obtained within a specified **time period**" (1972).

It has also the connotation of "blank" or "target".

This makes the concept ambiguous from the systemic viewpoint, because it is thus more or less implicitly surmised that the **entity** or system is conscious and volitive, which may very well introduce excessively anthropomorphic biases in any research about non-human as well as **human systems** (individual or social).

Even a keyed-down formulation as for example speaking about the final **situation** toward which the system tends, does not solve the difficulty, because "tends" seems still to imply voluntary **activity**. A good example could be what FREUD called "death wish". Every **living system** is somehow "death directed". This final and unavoidable **state** seems even to be inscribed in it since its beginnings, by way of the **2d principle of thermodynamics**, which impedes the very long term **maintenance** of **heterogeneous organization**.

However, **living systems** seem to pursue goals precisely in the opposite sense: their functional workings lead (aim?) to the **maintenance** of their **organization**. So, what?

Until now, nobody seems to have found any satisfactory term to replace "goal", that would solve these semantic difficulties. Let us thus remember to be very careful when using the word.

For the time being, RAPOPORT's definition is still the most honest, semantically speaking.

1439

GOAL COMPLEX^{1) - 4)}

A **hierarchical** ordering of the goals and sub-goals of a system (according to D.M. Mc KAY, 1969, p.112).

Complex systems are necessarily **hierarchized** because their global goal and principal subsidiary goals can be reached only through the orderly attainment of a number of lesser previous subgoals.

For example, to go out, I must first open the door. To open the door, I must first handle the knob. Therefore I must first move my arm and my hand, etc.

The correct ordering of a proper sequence of subgoals is an unavoidable need in order to reach a specified goal. Therefore, each and every **subsystem** concerned must function correctly at the precise instant.

→ **Priority of the simple**

1440

GOAL-DIRECTNESS¹⁾

A seemingly purposive and specific **activity** in a **living system**.

According to G. SOMMERHOFF: "The most distinctive character of the **behavior** of higher **organisms** is its goal-directness, its apparent purposiveness. In fact, it is largely through this apparently **teleological** nature of their **activities** that living **organisms** betray their exceptional **organization**. And their position on the "scale of life" is largely determined by the degree to which they possess these characteristics" (1969, p.148).

He further adds: "Many animal **activities** are patently goal-directed in a way which makes it clear that we are dealing here with an objective system-property – a property, moreover, which we can assume to be compatible with the basic laws of physics and chemistry. We can assume this because we know of **servo-mechanisms** and **automata** that are capable of essentially similar types of **behavior**" (p.149).

Orientation toward a goal, as a manifest tendency, seems to be a result of the growing **perception** of the **time-dimension** by evermore differentiated and complex **brains** throughout biological **evolution**. The most essential aspects of this are the capacity to memorize and the ability to figure out a growing number of possible future **situations**.

On this topic, SOMMERHOFF states: "The ordering **relations** here are in **time** as well as in **space**" (p.150) and... "The central nervous system more than any other part of higher **organisms** is responsible for introducing **teleological order** into the **activities** of the system" (p.151).

In this same paper SOMMERHOFF introduces the concept of **directive correlation** which eliminates the *finalist taint* of the goal-directness **concept**.

1441

GOAL SEEKING^{1) - 3) - 4)}

A characteristic of a system which directs itself toward the achievement of a goal.

This is a concept in need of a close scrutiny.

First of all, we should carefully distinguish what the system does from what we consider that it is doing.

The most general, and possibly the only really basic, "goal" of any system is its own perpetuation. We should here avoid the term "survival", because it would restrict the **concept** to the **living systems**. However, has any non-living system a "goal"? Does a galaxy have a goal, even if it seems to be self-perpetuating for eons? Does a crystal have a goal? Does a planet have a goal? Has **GAIA** a goal?

Really, proper goal seeking is probably restricted to living beings. But even then, in which sense could a bacteria or a virus have a goal? And when do goals appear: with **cells**?, with worms?, with vertebrates?, with mammals?, with apes?, with men?

And another tricky problem appears: do societies, species or **ecosystems** – which are not strongly **integrated systems** – have "goals"? Can they be "goal-seeking"?

As to our role as **observers**, we obviously attribute goals to many systems by **analogy** with our own goal seeking manner, and we frequently colour this concept with a shade of **free will**.

To become "goal seeking", even in the restricted sense of "survival seeking", a system must be **autonomous** (i.e. be **self-determined** in VENDRYES' sense) or **autopoietic** (i.e. able to maintain its **identity** by **recursive organizational closure**, in VARELA's sense).

To summarize, the **semantic** status of the **concept** is shaky.

For ACKOFF's views on the topic, see **System (Goal seeking)**

1442

GOALS CONFLICT^{1) - 4)}

A strong opposition or even incompatibility between the goals of distinct systems.

As D. Mac KAY explains, goals conflicts may arise between two (or more) systems "with incompatible goal-settings, and a common **field** of **operations**. In the ordinary way, each is bound to be driven by its (own) **feedback signal** to run eventually "flat out" in opposition to the other".

"How could this absurd and wasteful **situation** be resolved, or prevented from arising? In the absence of a third party, we must imagine one or both systems to possess some kind of an additional **effector**-system, capable of physical **action** upon the **environment**, to be brought in automatically when goal-conflict arises. The simplest one might be a destructive device of some sort deployed (presumably by each "side") with the sub-goal of cutting the power to the other, or otherwise put it out of **action**. Given a **situation** not too symmetrical, one system could then emerge triumphant and its primary goal would be attainable.

"Suppose however, that by **chance** or by **design**, the physical **activity** of one (or both) succeeded in altering the goal-setting of the other. Displaced in one direction, it would of course

make matters worse, but if instead the displacement brought the two goal-settings together, then we would have the beginnings of a wholly different kind of "resolution". Instead of being rivals, the two systems could evidently become partners, sharing the effort of furthering the common goal. The closer the approximation of their respective settings, the greater the economy of total effort" (1969, p.115).

Such a viewpoint is obviously of utmost importance for the resolution of conflict in general and, specially between social groups or systems. The setting of any reciprocal **regulator**, whose work must be paid for, entails a **cost**, but most generally results much less costly than the mutual damage resulting from open and unresolved conflict.

1443

GOALS (Hierarchies of) ^{1) - 2)}

The regulating or controlling arrangement of main and subordinate goals at different **levels**.

G. SOMMERHOFF writes: "Frequently, indeed almost invariably, various different forms of **goal-directness** or directiveness are all present and intimately interrelated in the same biological **situation**. This is a common source of confusion. In particular, one of the most distinctive characteristics of the living **organism** is the hierarchical manner in which the goals of various part-activities (or **activities** of its **parts**) are interrelated and integrated. In a typical case each **part activity** has a proximate and transient goal, which is itself subservient to the less transient and less proximate goal of the **action** as a whole, which in turn is subservient to the goal of the **behavior patterns** as such, and so on. Or it maybe the goal of one **activity** to establish or maintain the conditions under which another **goal-directed activity** can properly take its course while another **activity** in turn establishes or maintain the prerequisites for the first, etc... all of this involving **structures** and **mechanisms** which are themselves the product of directive developments. There is nothing to parallel this co-ordination and **integration** in the world of **machines** and **automation**" (1969, p.150).

As to this last statement, it should be taken into account that it has been pronounced in 1969.

Goal degradation, i.e. the provisional or definitive giving up of higher **level** goals in systems struggling for **survival** is a significant aspect of the **General Adaptation Syndrome**. It seems to correspond to a return to the "basics", as stated by L. SKYTTNER, in relation to the "bottom of pyramid of needs, the reptilian brain" (1992, p.5).

To resume, goals are hierarchized in **space** and **time**. This corresponds to the fact that **living systems** do maintain a transforming **coherence** in **time** (by **morphogenesis**, **structuration** and a tendency to **dynamic stability**).

→ **Priority of the simple**

1444

GOALS (Space of) ²⁾

The partly ordered **set** of the successive goals of a system.

A. LOCKER et al described the goals **structure** of a **teleogenic** system. Their **model** is a **lattice**. When this **lattice** is **embedded** in a more adequate and complete one, it becomes possible to study the way newer goals are searched for (1975, p.27).

1445

GOALS (Variable) ²⁾

The different but compatible goals that coexist and generally enhance each other in a complex system.

Variable goals are a characteristic of complex systems, which are not confined to the sequence **stimulus-response**, nor even to some **binary** or dichotomous **control**.

The **autonomous complex system**, being **equifinal**, is able to chose among a number of possible intermediate goals the one that best suits its global **stability**, and becomes a kind of superseding general goal, acting as a **selector** of convenient intermediate ones.

1446

GOALS WITHIN GOALS ¹⁾

I. BLAUBERG et al., develop an idea akin to SOMMERHOFF's one in the following terms: "The adequate specification of the goals of a given system **organization** requires the preliminary determination of the goals of a larger system which includes the given one. This is a necessary condition for determining the real **functions** of a given system within a certain larger **whole**; this **functions** and thus the goals of a given system are obtained from an analysis of a certain **set** of mutually dependent **functions** and goals of a larger system..." (1977, p.277).

In HEGEL's terms, who of the master and the slave is, in the end, the master? It would seem, in view of the obvious **interdependence**, no one... or both.

1447

GOAL-SEEKING SYSTEM ^{1) - 3)}

W. R. ASHBY writes: "Every **stable system** has the property that if displaced from a **state of equilibrium** and released, the subsequent movement is so matched to the initial displacement that the system is brought back to the

state of equilibrium. A **variety** of **disturbances** will therefore evoke a **variety** of matched reactions.

"This pairing of the line of return to the initial displacement has sometimes been regarded as "intelligent" and peculiar to living things. But a simple refutation is given by the ordinary pendulum: if we displace it to the right, it develops a force which tends to move it to the left; and if we displace it to the left, it develops a force which tends to move it to the right. Noticing that the pendulum reacted with forces which though varied in direction always pointed towards the centre, the mediaeval scientist would have said "the pendulum seeks the centre". By this phrase he would have recognised that the **behaviour** of a **stable system** may be described as "goal seeking". Without introducing any metaphysical implications we may recognise that this type of behaviour does occur in the **stable dynamic systems**" (1960, p.54).

→ **"LE CHATELIER Principle"**.

As human systems (personal and social) describe their goals and pursue them in a willful way (i.e. an at least seemingly not rigorously pre-determined way), one may wonder if the words "goal-seeking" should be used for all types of systems.

Even a biological system as an animal, which exhibits many kinds of complex **activities** is not simply responding passively to a **stimulus**, which is the case with the pendulum.

In any case, a true goal-seeking seems to necessarily imply corrective **feedback**.

ASHBY himself states: "**machines** with **feedback** are not subject to the oft-repeated dictum that **machines** must act blindly and cannot correct their errors" (p.55) and moreover: "A system which possesses **feedback** is usually actively **stable** or actively **unstable**; and whether it is **stable** or **unstable** depends on the quantitative details of the particular arrangement" (p.54).

1448

GÖDEL'S INCOMPLETENESS THEOREM ^{2) - 3)}

Formal logic version: "For every consistent formalization of arithmetic, there exist arithmetic truths unprovable within that formal system".
Complexity version: "There exist numbers having complexity greater than any theory of mathematics can prove".

Both version are given by J. CASTI (1994, p.139/146).

At the beginning, the theorem seemed to be merely a formal logical one about arithmetic truth, in correspondance with the formal logic version.

Various different versions have appeared through time, and slowly, it dawned that "... we'll never get at all the truth by following **rules**; there is always something out there in the real world that resists being fenced in by a deductive argument" (p.150).

G. CHAITIN has been one who most insistently inquired into the matter.

"If a theorem contains more **information** than a given **set** of axioms, then it is impossible for the theorem to be derived from those axioms" (Cited by Joseph FORD, 1989, p.609)

"...in a **random** sequence each sequential digit carries positive **information** since it cannot be predicted from **knowledge** of its predecessors. In consequence an infinite **random** sequence contains more **information** than all our finite human logical systems combined, hence, verifying its **randomness** lies beyond constructive proof" (Ibid).

"...in all truth, GÖDEL permeates the physical world even more than he does the mathematical. Indeed we now have no choice; we must come to grips with GÖDEL, with the paradox of solving the unsolvable, predicting the **unpredictable**" (Ibid).

(as stated by F. HEYLIGHEN)

"...in each formal system (containing the axioms of number theory) there exist propositions such that it is impossible to distinguish between the **truth** (probability) and falsity of the proposition within the system itself" (1990a, p.441).

Although this seems a purely negative statement, it "can also be interpreted in a positive way by moving to a higher **level of representation**, where (it) expresses a certain high-order **closure**.

"The theorem of GÖDEL is proven by means of a construction allowing the formal system to represent propositions of the system by numbers so that it is possible to interpret propositions about numbers to be propositions about propositions of the same system. This **self-reference** is an example of cyclical **closure**. The incompleteness result can be understood as an application of the more general principle of the impossibility of complete **self-reference** (LÖFGREN)" (p.441).

GÖDEL's theorem is related to A. CHURCH's work. As stated by R. SCHOENFELD: "CHURCH's thesis (is) that decidability is equivalent to **recursiveness**, which is equivalent to computability" (1994, p.88).

The practical systemic meaning of GÖDEL's incompleteness theorem is thus resumed by J. CASTI: "A universal feature of **knowledge** is that one must get outside of a system in order to really understand it" (1994, p.17).

1449

GOLDEN PROPORTION ^{2) - 4)}

The **limit** to which tends the ratio of two successive numbers of the **FIBONACCI series**.

The value of the golden proportion (or section) is

$$\frac{(\sqrt{5}-1)}{2} = 0,618$$

It has been considered since Antiquity as reflecting the basic harmonies of nature. A specific angle, the Golden section, i.e. 137°30' corresponds to the Golden proportion.

The so-called and related Golden number is the limit of the series 1/1, 1/2, 2/3, 3/5, 5/8, 8/13, etc., i.e. again:

$$\frac{(\sqrt{5}-1)}{2} = 0,618$$

From the systemic viewpoint it corresponds to the **cyclical organization** of material **structures**, as a result of reciprocal influence of **fields** of forces. It tends to produce **helical** orderings of **elements**. It reflects the relation between **parts** and **whole** in progressive construction. It also seems related to the **fractalization process**. It can be encountered in many natural systems. See, for ex. St. DOUADY and Y. COUDER's study on vegetal spirals (1993, p.26-35).

The Russian sociologist A.A. DAVYDOV has researched in the recent years the role of the golden proportion in social systems (1992, p.19-25).

1450

GOVERNABILITY ⁴⁾

The supposed or real possibility to govern systems.

In any case, governability is at best a limited possibility. R. VALLÉE observes: "The governability problem is the steering problem: A **dynamic system** is perfectly governable if, whatever the initial instant and initial **state**, and whatever the final instant and final **state**, it is possible to find an **input function (command)** that, applied from the initial to the final instant, gives the possibility to lead the system from the initial to the final **state**".

VALLÉE is however somewhat skeptical: "There is a certain mathematical **duality** between **observability** and governability and it is obvious that a system cannot be totally governable, just the same as it cannot be completely observed" (1995, p.23).

Governability therefore, is not much more than hypothetical wishful thinking, even in **human systems**. Within the **limits** of a more or less **metaphorical** comparison, insect societies appear to be **self-steered**, i.e. their members automatically create a global **order** through their **interactions** and, at the same time, become submitted to it. Could human societies really be "governable" in a different and more volitive sense?

→ "**stigmergy**".

In insect societies, global **reliability** is obtained, just like in a **von NEUMANN automaton**, notwithstanding the possible poor quality of some **components**.

If human **sociosystems** are self-governed, or **self-steered** in the same way, the nature, **goals** and achievements of politics in its most general and **purposeful** sense become very difficult to assess.

Finally, governability is in most cases an illusion. In St. BEER words, who had much practical experience of such **situations**: "A minister can always call for an elaborately reorganized **set of data**, on which complicated mathematics have been done; but it is the computer that generates the **variety**, and not the real world This is quite fundamental nonsense" (1974, p.40)".

1451

GOVERNANCE ²⁾

The **process** of directing a system towards some pre-defined **goal**.

In G.G. JAROS words: "Governance rests on the application of **feedback** and **feedforward** which ensure that the **teleos** (i.e. "**goal**" in JAROS terminology) is reached" (1994, p.5).

As most of the systems to be governed are complex and **nonlinear**, governance should not be taken as a simple (nor even complicated) **deterministic** procedure. **Feedback** and **feed-forward** may very well in some cases fall wide off the mark.

1452

GOVERNANCE (WORLD)

→ **World Governance**

1453

GOVERNOR ^{2) - 4)}

Any internal device that is supposed to **control** a system or a **subsystem**.

G. BATESON considers this term to be a misnomer and states: "... no **part** of ...an internally interactive system can have unilateral **control** over the remainder or over any **part**... Even in very simple corrective systems, this **holistic** character is evident... The governor is, essentially, a sense organ or **transducer** which receives a transform of the **difference** between the actual running speed of the engine and some ideal or preferred speed... The **behavior** of the governor is determined in other words, by the **behavior** of the other **parts** of the system, and indirectly by its own **behavior** at a previous **time**" (1973, p.286).

This semantic muddle is responsible for:

- 1) the misunderstandings about the concept of **control** (see "**control of and control for**");
- 2) the negative fame earned by **mechanistic cybernetics** with psychologists and social scientists, who fear possible psychic and social abuse by self-styled would be "**controllers**".

1454

GOVERNOR MECHANISM (Virtual)¹⁾²⁾⁴⁾⁵⁾

A complex **control** in a **network** obtained through reciprocal compensation among a **set** of oscillating **elements**.

Such a mechanism is described by P. Smith CHURCHLAND, who gives the example of a set of electrical generators, each of them presenting "**fluctuations of frequency** of 10% around some average value"(1989, p. 365)

"Taken joined together in a suitable network, their collective frequency **variability** is only a fraction of that figure because, statistically, generators momentarily fluctuating behind the average **output in phase** are compensated for by the remaining generators, and conversely, generators momentarily ahead in phase have their **energy** absorbed by the remainder. The entire system functions from an **input/output** point of view, as a single generator with greatly increased frequency **reliability**, or as control engineers express it, with a single, more powerful, "virtual governor"(Ibid)

This example underline a basic characteristic of networks: Their **efficiency** as a **whole** makes them advantageous as a whole, but also for every participant. This explains how and why networks are the typical device for any kind of social **organization**.

→ **Automata (Reliability of); Co-evolution; Correlation device; Correlation (Directive); Feedback (self-normative); Oscillator; Regulator; Reliability in dynamic terms; Sociality; Socialization**

1455

GRADIENT^{1) - 2)}

Difference between some energetic or material **level** existing between a system and its **environment** or within **subsystems** of the same system.

Such differences normally produce **flows** which may disappear progressively through a diffusion **process**.

Gradients are at the same time a condition and a manifestation of a system's **heterogeneity** (or **organization**) and a condition of the existence of the system within its **environment**.

Their decrease implies an increase of **entropy**.

Every gradient is linked with a corresponding **flow**, which is termed "conjugated **flow**".

R. THOM observes that, while gradients are quantitative, they offer also various qualitative aspects (1991, p.107). These result partly from their **interactions**.

An example can be the "**conflict** between horizontal polarity and vertical direction, which are dual in our **space**" (p.112).

Thom also explains that **attractors** correspond to maxima in gradients (p.161).

1456

GRAMMAR¹⁾

"A **set of rules**" (R. ROSEN, 1972, p.63).

This term, introduced in this sense by ROSEN, is useful, as it conveys in a kind of short-hand a **meaning** of interconnected globality.

A grammar prescribes a **combinatorics** stating admitted **congruences**, and defines **constraints** in any **communication language**.

1457

GRAMMAR (Generative)¹⁾⁵⁾

"The **brain programs** that are followed in generating the sentences in a **language**" (J.Z. YOUNG, 1978, p.293)

Young explains: "A set of phrase **structure programs** provides the deep structure, and transformational programs generate various surface structures"

He gives as an example: "Cows eat grass", "Grass is eaten by cows" or "Can cows eat grass?" (Ibid).

1458

GRAMMAR (Universal)¹⁾³⁾⁵⁾

The **set of rules of languages** construction that are common to all **languages**

This concept has been introduced by N. CHOMSKY and its validity is today generally admitted. Grammar in this sense includes:

- phonetic **rules**, which define the ways sounds are produced
- **morphological rules**, which define the ways words are constructed from sounds
- **semantic rules**, referred to the **organization** of the system of **meanings**

However, as commented by EDELMAN, any specific **language** must be learned, i.e. any **language** act is intersubjective, occurring between at least two individuals. Moreover it is also learned within a specific **culture**, which historically defined the **symbols** used (1992, critical postface).

→ **Learning matrixes (Steinbuch's)**

1459

GRAMMAR¹⁾³⁾⁵⁾

"The set of **brain programs** by which sentences are generated" (J.Z. YOUNG, 1978, p. 293).

Such programs, whose **description** and even nature are still quite far to be completely understood, are related to at least three aspects of natural **languages**: the formation of **phonemes** (elemental sounds), of morphemes (words) and the **rules** for the construction of sentences.

The construction of **meanings** seems to be still at a fourth **level**, since it is perfectly possible to construct apparently well structured sentences, devoid however from any meaning, as for ex. "Ospakat waza umbin sra dnefgo"(w-hich has no sense at all) , or the following:

"Mutoto alivunja sahani moya", which is significant in Kiswahili... if your brain did assimilate the **meaning code** corresponding to that language.

1460

GRAND ENSEMBLE^{1) - 2)}

A totally interconnected **network**.

St. KAUFFMAN, who introduces this type of **networks**, writes: "Since each **element** receives an **input** from all other **elements**, there is only one possible wiring diagram... this ensemble corresponds to the largest possible ensemble of **Boolean networks** of **N variables**" (1993, p.192).

He also states: "The Grand Ensemble is maximally disordered" (p.472), and, as a result, its **behavior** is **chaotic** (Ibid).

It is interesting to observe that a type of maximal **disorder** corresponds to the maximum number of **constraints** in what ASHBY calls "**richly joined systems**". The most useful or creative systems are thus those that are moderately constrained, admitting sufficient leeway for **adaptations**.

1461

GRAPH GRAMMAR²⁾⁵⁾

D. GERNERT proposed graph grammar as follows: "A mathematical technique which supports characteristic operations including the generation, transfer, **recognition**, interpretation and application of **patterns**" (1997, p. 179)

Moreover "...**parallel processes** can be described by parallel graph grammars"(Ibid)

Gernert characterizes the basic patterns:
Pattern generation: the building up of a greater unit, not from **elements**, but from already existing building blocks

Pattern transfer: the duplication and insertion in different **locations** of an already existing pattern

Pattern recognition: an act of classification where a **classification** scheme has been previously defined

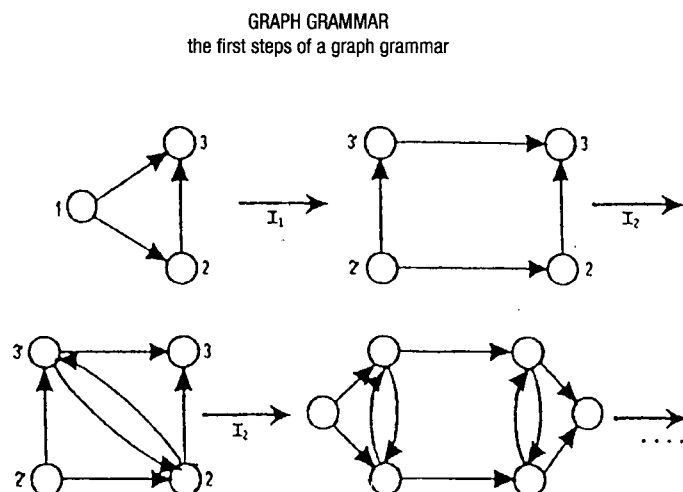
Pattern interpretation: an interpretation **process** of an existing pattern in a system that can influence the system's development

Pattern application: the triggering of a **change of state** by the transfer of a pattern to another location

As patterns are **interrelations**, it is possible to represent them by graphs. Complex graphs can be constructed step by step, using a "cellular graph automaton", i.e. "an underlying graph where in each **vertex** an **automaton** equipped with an **algorithm** is installed"

see figure next page

Figure: see entry **Graph Grammar**



The fig. is from GERNERT, Dieter:

"Graph grammar as analytical tool in physics and biology" – Biosystems 43, 1997.

Gernert gives an overview of the field (opened up by K. Zuse in 1975) which is developing steadily in theory and through applications in physics and biology.

→ **Artificial life; Game of life; Graph theory; Graph (transformation); Hora and Tempus parable; Hypercube; Network; Transfer function**

1462

GRAPH GRAMMAR (Sequential) ²⁾⁵⁾

D. GERNERT explains how graphs can be re-written, thus generating a sequential graph grammar through **embedding rules**. He describes as follows some important properties of this type of representation graphs:

1. The new graph generated by a production rule can be "more complex" or "less complex" than the old one
2. The continuation of the rewriting process is not necessarily unique: there may be non-determinism as well as determinism, or a combination of both, depending on the features of the individual graph grammar
3. There may be different sequences of derivation steps which lead to the same result, the "genesis" of a graph is not necessarily unique
4. A sequence of derivation steps can lead to the start graph again: "periodic graph grammars" are possible
5. In degenerate cases it may happen that none of the production rules are applicable so that the procedure stops

→ **Graph (Parallel rewriting of a); Rewriting**

1463

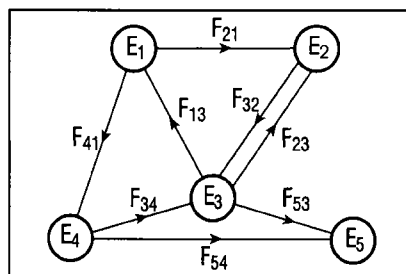
GRAPH (Group of a) ²⁾

"The collection of all its automorphisms" (F. HARARY, 1967, p.25).

Different graphs can be topologically **isomorphic**, and thus reunited through a **group**.

F. HARARY writes: "It is a permutation **group** acting on the **set** of points (**nodes**). It is known (FRUCHT, 1949) that every finite **group** is abstractly **isomorphic** to the **group** of some graph" (Ibid).

This author also defines the **line (edge) group of a graph**: "The permutation **group** whose **objects** are the lines of G and whose permutations are induced by those of the **group of automorphisms**" (Ibid).



A transformation graph.

From P. DELATTRE: 1974, p. 106

1464

GRAPH of a FUNCTIONAL NET ²⁾

Any **oriented graph** used to represent the multiple **interconnexions** in a complex **function** in a biological **organism** or a human **organization**.

N. RASHEVSKY showed how to establish graphs of this type. Such graphs correspond to a very general type and can be used as **isomorphic functional models** of numerous and very different **classes** of systems. RASHEVSKY gave many examples in his paper and, moreover, showed how to interconnect various partial graphs which represent different specific as-

pects of a complex systemic **function**. (1956, p.126-34; also 1960, p.345-70).

St. BEER states: "The **vertices** of a graph are regarded as **elements** of a **set** which is mapped into itself, of which **set** the graph is then a multi-valued **function**" (1968, p.218).

1465

GRAPH (Parallel rewriting of a) ²⁾

A. LINDENMAYER and K. CULIK II state that, when we plan to describe a system throughout an extended period of **time**: "... we have to introduce **rules** by which a new graph can be produced from a previous one. Using such a system of **rules**, one obtains either a sequence of graphs (in their order of development), or a **set** of graphs (without an ordering)...

"A parallel graph rewriting system in our sense consists of a set of **node labels**, a set of **production rules**, a set of **connection rules**, and a starting graph" (1979, p.46).

This introduces **transformation graphs**.

1466

GRAPH THEORY ²⁾

A branch of mathematics dealing with the properties of the **links** between points or **nodes** in a **network**.

Graph theory, introduced by D. KÖNIG in 1936, is practically a formalized taxonomy in qualitative mathematical terms of the multiple possible types of **interconnections** between discrete **elements**.

There is a close relation between graphs and **matrixes**: A graph can be represented by a **matrix**, and vice-versa.

H. ATLAN writes: "The interest of graphs is that they do not only produce a pictorial **representation**, but that moreover their logical properties allow for an **algorithmic** writing – i.e. automatic – of the **state** equations of a system".

D. GERNERT even proposes a "graph **grammar**" as "a formalism which allows the derivation of a new graph from an old one by a sequence of consecutive derivation steps" by the use of "graph **rewriting** systems" (1989, p.66).

According to A. KAUFMANN, graph theory is "... that field of **set theory** concerned with the **binary relations** of a **set** with itself, admitting that the **set** is countable. This theory is not autonomous in relation to the other developments of the **set theory**, but it possesses a specific vocabulary, very extensive and specialized, it opens a very large field of applications in physics, in economy, in psychology, in telecommunications, in organic chemistry, in **organizations**, in certain artistic domains, etc..." (1970, p.1).

As such, it is undoubtedly a quite basic tool for general system **modeling** and deserves in itself a complete study. Hereafter, a host of co-ordinated – and, as far as possible, standardized – definitions are given, with short comments. This material is essentially based on references from F. HARARY (1967), P.W. KAS-TELEYN (1967), A. KAUFMANN (1970), G. KREWERAS (1972), S. LIPSCHUTZ (1976) and A. SACHE (1974). Generally no precise references are given hereafter, as the following is a blended synthesis of these authors views.

According to the general character of graphs, few references are made to any specific properties in particular disciplines.

Definitions given correspond to 2-dimensional **representations**. It is however possible, although much more difficult, to conceive 3-, 4- or n-dimensional **representations**, as for example the 4-dimensional **hypercube** with 16 **nodes**, which can be associated, for instance, with **time** sequences along connecting **edges**. see figure page 174

To begin with, F. HARARY observes the rampant terminologic confusion that affects the field and establishes the following equivalences (1967, p.4):

"point _ vertex _ node _ junction _ 0-simplex
 "line _ edge _ arc _ branch _ 1-simplex
 "cycle _ circuit _ elementary cycle _ circuit path _ polygon
 "path _ arc _ elementary path _ simple path _ chain

We have selected the underlined terms, but this is merely a more or less arbitrary decision, based on the necessity to avoid ambiguities. We would not dream to add still more confusion, but had it not been nice to call "arrow" (used by St. KAUFFMAN, 1993), the *oriented edge* ? We start thus with these four basic definitions:

NODE: A discrete element in a graph

EDGE: A direct connection between two nodes

ARC: An oriented edge between two nodes.

POLYGON: A closed succession of arcs such as the last node is the same as the first one.

The principal types of graphs are:

DIGRAPH, or directed graph, which consists of:

- a set of elements (nodes)
- a set of arcs (directed edges). The arcs define relations, sometimes also called "influences".

Digraphs can be *labeled*, i.e. affected with some kind of data. "Such graphs are frequently used to picture dynamic **situations**" (LIPSCHUTZ, 1976, p.119).

A digraph "is *strongly connected* or *strong* if each point (**node**) is reachable from each other point (**node**)...(it) is *unilaterally connected* or *unilateral* if, for any two points (**nodes**), at least one is reachable from the other...(it) is *weakly connected*, or *weak* if, for any division of its set

of points (**nodes**) into two non-empty subsets, there is a line (**edge**) from a point (**node**) of one subset to a point (**node**) of the other" (HARARY, 1967, p.18).

Finally, it is *disconnected* if at least one node cannot be reached from any other.

"A **source** (**root**) of a digraph is a point (**node**) from which all other points (**nodes**) are reachable" (Ibid).

In this sense, a source or **root** is the inverse equivalent of a **sink**.

J. WARFIELD advocates extensive use of digraphs to map **structural models** of complex systems as a way to what he calls "Interpretive Structural Modeling" (1989b, Chapter 10).

He writes: "A graphically integrated language offers advantages in representing complexity. Such a language can have well-defined graphic symbols, and layers of representation of differing sophistications" (1995,e). **TREE**: "A finite connected graph with no cycles (**polygons**)" (LIPSCHUTZ, 1976, p.87).

"The tree consisting of a single vertex (**node**) with no edges is called the *degenerate tree*" (Ibid, p.105).

A tree starts from a **root R**, i.e. a **node** which does not receive any **arc**. Any other **node** in the tree receives only one **arc**. The tree may bifurcate at any successive **node**, including A and these **bifurcations** can be multiple (A. KAUFMANN, 1970, p.90).

As a result, there is a unique **path** from R to any **node** in the tree and the length of the **path** from R to any **node N** is made of n arcs, whose number characterizes the *depth* of N.

The end **node** in any **path** is called a **leaf** and the **path** from the **root** to a **leaf** is a **branch**.

Trees are very useful for the description of hierarchical organizations.

A **MULTIGRAPH** is a graph containing multiple edges connecting the same nodes and specially, loops, which are edges whose end node is the original node itself. According to S. LIPSCHUTZ: "The definition of a graph does not permit such multiple edges or loops. In other words, we may define a graph to be a multigraph without multiple edges of loops" (1976, p.82).

Furthermore: "A multigraph is said to be finite if it has a finite number of vertices (**nodes**) and a finite number of edges" (Ibid., p.83).

A **SUBGRAPH** of a graph is a distinguishable part of the graph which is itself a graph. A good example is the set of the local roads on a map giving also the national roads. A subgraph may be or not be connected to the general graph. Subgraphs are generally more strongly and specifically connected than the graph as a whole.

Numerous types of more specific graphs have been defined, as for instance:

- The **acyclic graph**, which has no **cycle** (**polygon**): "A finite connected graph with no cycles is called a **tree**" (LIPSCHUTZ, 1976, p.87).
- The **anti-symmetric graph**, in which the nodes may be connected by uni-directional arcs only. Examples are a genealogical tree, or the military hierarchical command order
- The **bipartite graph**, whose edges can be partitioned into two complementary subgraphs in such a way that each node of one subgraph is connected at least to a node of the other.
- The **complementary graph** which, by combination with another graph, constitutes a complete graph.
- The **complete graph** of which any node is connected to every other node. If the connections are merely edges, the graph represents a **structure**. It can be dynamized by the replacement of the edges by arcs.
- The **connected graph** in which there is always at least one path between any two nodes. However, even a unconnected graph may contain connected subgraphs.
- The **strongly connected graph** would be, after KAUFMANN, the central subgraph within a graph, in which all possible arcs between all nodes do exist.
- The **Eulerian graph** in which there is which there is a complete trail (walk) traversing the whole graph by a non-repetitive succession of edges or arcs. The typical non-Eulerian graph is the famous Koenigsberg bridges example studied by EULER (1736) and showing that no possible totally non-repetitive trail did exists for crossing the seven city's bridges once only in the same walk.
- The **full graph** is that one wherein all nodes are reciprocally connected one to one by two arcs of opposite direction (KAUFMANN, 1970, p.16).
- The **Hamiltonian graph** is the graph in which a closed walk includes every node once and only once.
- The **labeled graph** in which "...edges and/or vertices (nodes) are assigned data of one kind or another" (LIPSCHUTZ, 1976, p.89).
- The **non-polygonal graph** in which there is no closed route between nodes. If such a graph is connected by arcs and if there is a circulation of flows entering by one node only, the graph becomes more or less definitively disconnected if the flow is interrupted, even briefly.
- The **oriented graph** whose all edges are arcs.
- The **random isotropic directed graph** in which an increasing number of randomly introduced oriented edges (arrows) lead to critical thresholds at which the con-

nectivity properties change abruptly (St. KAUFFMAN, 1993, p.423). The condition is that the ratio of the number of arrows to the number of **nodes** must surpass a certain limit.

- The **symmetric graph** in which each **arc** joining one **node** A with another **node** B is complemented by a reciprocal **arc** BA.

Graphs of different **networks** can be compared.

Isomorphic graphs "can be represented by the same abstract graph... if there is a one to one correspondence between their **elements** which preserves the incidence relation" (KASTELEYN, 1967, p.50).

Homeomorphic graphs are merely **isomorphic** in relation to some specific property of their **structure**. A square is **homeomorphic** to a diamond or a rectangle.

These different types of graphs can be used for different **network situations**.

Hereafter, some more definitions related to graph theory are given (or repeated).

BRANCH: In a **tree**, the **path** from the **root** to a **leaf**.

CHAIN: A continuous sequence of **arcs**.

CIRCUMFERENCE: The length of the longest **polygon** (or **cycle**).

CUT POINT (or OUTPOINT): In a **connected graph**, any point (**node**) whose removal results in a disconnected graph.

FOREST: A graph with no **polygons**, i.e. whose all **subgraphs** are **trees** with interconnected **roots**.

GIRTH: The length of the shortest possible **polygon** (In J. WARFIELD 1989b, p.338: **geodetic cycle**).

HEAD: In an **oriented graph**, the first **node** in a **chain**

LOOP: An **edge** or **arc** whose origin and extremity coincide

MATRIX (Connection): The matrix which represents in a **binary** numerical form the **edges** or **arcs** and the connected **nodes**

NODE (Unreachable): A node not connected by any **edge** or **arc**. LIPSCHUTZ calls it an "isolated vertex".

NODE (Degree of a): The number of **edges** that are incident on it. This is the sum of the number of incoming and outgoing **edges**. BRYANT calls it the "valency" of the node

NODES (Distance between): The total length of the shortest **path** connecting them.

PATH: A **walk** with distinct **edges**. A path is simple if it does not use twice the same **edge**. It is elemental if it does not use twice the same **node** (Hamiltonian path).

ROOT: A **node** from which all other **nodes** can be reached. HARARY calls it "source". In a **tree** the root emits but does not receive.

SINK: A **node** which receives but does not emit, i.e. the opposite of a **root**.

TAIL: In an **oriented graph**, the last **node** in a **chain**.

TRAIL: A **walk** with distinct **arcs** (Eulerian trail).

WALK: According to LIPSCHUTZ: "... an alternating sequence of vertices (**nodes**) and **edges**... The number of **edges** is called the length of the walk" (p.83).

WALK (Self-avoiding): A walk in which all **nodes** are distinct, with the possible exception of the first and the last ones (KASTELEYN, p.51).

WALK (Spanning): A walk which "... contains all the vertices (**nodes**) of the **digraph** (Ibid., p.120).

WALK (Steps of a): The **edges** included in the walk. (Ibid, p.51).

A last mention should refer to the **P.E.R.T.** (- **Process** Evaluation and Review Tasks", a method to rationally order subtasks in a complex project. A **P.E.R.T model** is a graph extended into the **time** dimension, in which the shortest possible **temporal path** is sought by an optimal ordering of tasks.

1467

GRAPH (Transformation)²⁾

A graph that represents all the possible **states** of a system and all the possible **transitions** from one **state** to another.

This **model** was proposed and widely developed by P. DELATTRE and used by him in radiobiology and radiotherapy. (1974). It can however be used for the **representation** of **transitions** from **state** to **state** in any kind of **complex systems**.

1468

GREY BOX²⁾

A kind of **black box** which is known to contain some internal intervening **variables** acting as links between **inputs** and **outputs**.

In a grey box, at least something is known about the inner **transformation mechanisms** of the box.

According to M. BUNGE, **automata** are grey boxes, which may be **deterministic** if the same types of **inputs** produce the same **outputs**, or **probabilistic** if they produce only probable **outputs**. (1979, p.263).

Such **models** "are of greater interest than **black box models** because, unlike the latter, they take into account not only the **behavior** but also the internal **states** of a system" (Ibid). **Complex systems** are similar to grey boxes, in that we know something of their internal **mechanisms**, but not enough to make them perfectly, or even reasonably **predictable**.

1469

GROOVING¹⁾

The progressive **reinforcement** by successful repetitions in a **learning process**.

In the nervous system, grooving is a result of **HEBB's rule** of synaptic circuit **reinforcement**. A similar **process** exists in all natural or artificial **learning networks**, including **social systems**. While it is needed to stabilize **knowledge**, it may lead, when excessive, to overlimiting **constraints**, that can block further **learning**.

1470

GROUP^{1) - 4)}

"A set of single **organisms**, commonly called **members**, which, over a **period of time** or multiple interrupted **periods**, relate to one another face-to-face, processing **matter-energy** and **information**" (J.G. MILLER, 1978, p.515).

This is the fourth **level of complexity** in J.G. MILLER's **taxonomy of living systems**.

A group is made of interacting biological **organisms**.

The group becomes organized in order to execute useful tasks that its participants would not be able to tackle individually.

1471

GROUP (in mathematical sense)²⁾

A **set** of **elements** provided with an internal composition **rule** with the three basic following conditions

- the **rule** is associative;
- it admits one neutral **element** e ;
- any **element** of the **set** can be symmetrized: $a \cdot a^{-1}$

(adapted from L. CHAMBADAL, 1969, p.107).

The group operates **transformations** on the **set** of the general form: $a \cdot a^{-1} = e$. This implies that the **set** is closed and self-generating, i.e. that any **operation** on an **element** of the **set** gives another **element** of the **set**.

R.D. CARMICHAEL, gives some examples of groups:

"- the **set** of integers, positive and negative and zero, the **rule** of combination being ordinary addition, (the identity (i.e. **neutral element**) is zero; the inverse of an **element** is its negative);...

"- the **set** of all real numbers except zero, the **rule** of combination being ordinary multiplication (Here unity is the identical **element**, and the inverse of an **element** is its reciprocal)" (1956, p.17).

Another interesting example are the **rotation** groups of Euclidian geometry, as for example the group - i.e. the various types of rotations around a vertical axis - that conserves the **symmetries** of an equilateral triangle.

These **transitions** can be represented by a **matrix**.

More generally, the postulates of Euclidian geometry generate a group, as they correspond to a collection of rigid motions which may transform a geometric figure into itself.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

CARMICHAEL also states: "The **elements** common to two finite groups G1 and G2 form a finite group H known as the common subgroup of G1 and G2." (p.46).

This is useful for the formalization of partial **isomorphisms**.

The group **concept** is akin to those of **hyper-cycle** and **organizational closure**, as observed by J. SINGH (1972).

Autopoiesis could thus possibly be modeled through group theory.

W.R. ASHBY enounced the following theorem: "The lines of **behavior** of a **state-determined system** define a group" (1960, p.244). Thus the **concept** of group is related to **topological stability**.

While mathematical groups are used to study the properties of **symmetric** systems, they can also be used to classify the ways **symmetries** can break.

"The late appearance of groups in science shows that a theory based on them could only have resulted from the modern mathematical **method** of **generalization** and **abstraction**, the **method** of thinking in terms of "system".

"With such concepts as **"set"**, **"group"**, **"ring"**, **"field"**, mathematics reached a stage of great generality. The object of its study is no longer the special character of certain **magnitudes**, but the **structure** of whole **domains**. In this way it becomes possible to make statements that are valid for many different **fields**. For an over-all summary or synthesis of widely varied parts of mathematics, the notion of a group has become indispensable" (Adapted from H. BEHNKE & al., 1987)

1472

GROUP TECHNIQUE (Nominal)^{2) - 4)}

A technique "used to enable a participant group to generate, clarify, and to initially assess relative saliency of factors relevant to an **issue**" (J. WARFIELD, 1989, p.2)

WARFIELD uses this evaluation technique as a feature of his "Interactive Management" and "Generic Design Science". It is meant to reveal ideas, opinions and beliefs of participants about some **issue**, and to measure their **diversity**.

He explains the technique as follows: "Members of the group work from a **context** statement about the **issue** to generate ideas about the **issue**, silently. Then there is a round-robin recording of the ideas. Next there is a formal period of clarification of the ideas, aimed at assuring that anyone in the group has the opportunity to understand every idea. As used by the Center for **Interactive Management**, the last step in applying NGT is to ask each individual member of the group to vote anonymously on what that individual believes are the five "most important" ideas in the **set** of ideas that remains after clarification. This voting record becomes part of the permanent **data set** on how members of the group share or do not share

beliefs about relative importance of constituent factors in the complex **issue** under consideration. It allows a ranking **pattern** to be produced reflecting a group product at a certain point in time in considering the **issue**" (1991, p.198).

1473

GROUPTHINK^{3) - 4)}

"The deterioration of mental efficiency, quality of reality testing, and quality of moral judgment that results from in-group pressures" (J.N. WARFIELD and C. TEIGEN, 1993, p.4).

The authors comment: Subject to Groupthink, a group may seem to accept a specific **decision**; however, if individual group members are confronted with that point of view separately from the group, few members would accept that view as their own" (Ibid).

Groupthink results from role **dissymmetries** among group members. "Specific **behavioral patterns** found in Groupthink involve such **roles** as "gatekeeper", "whip", etc., that distinguish one member from another. Certain individuals dominate the discussion. Individuals known to have views not compatible with whatever viewpoint is being favored may be silenced or excluded from the group" (J. WARFIELD, 1995a, p.65).

I.L. JANIS, as quoted by WARFIELD describes the eight symptoms of Groupthink:

"1. An illusion of invulnerability, shared by most or all of the members.

"2. Collective efforts to rationalize in order to discount warnings.

"3. An unquestioned belief in the group's inherent morality.

"4. Stereotyped views of rivals and enemies.

"5. Direct pressure on any member who expresses strong arguments against any of the group stereotypes, illusions, or commitments.

"6. Self-censorship of **deviations**.

"7. A shared illusion of unanimity ... augmented by the false assumption that silence means consent.

"8. The **emergence** of self-appointed mindguards" (1994b, p.259).

A still more nocive variant of Groupthink is **Clanthink**, wherein *everybody* is subservient to generally unperceived mental **constraints** resulting from unexpressed - and sometimes hidden - cultural **values** and **norms**.

1474

GROWTH¹⁾

Functional and **structural** increase in an individual system or a **population**.

K. BERRIEN stated: "Growth may be viewed as **structural** modifications initiated by some "foreign" **input** permitting the acceptance of (more) **maintenance inputs**".

Accordingly:

"a. **Emergent** characteristics of systems are the necessary consequences of growth and attendant modifications.

"b. Because growth modifications are such as to permit the system to be maintained more efficiently, they can be viewed as **adaptations**.

"c. Growth is limited by **adaptation limits** and **memories**.

"d. Growth follows a "plan" **embedded** in **substructures** of the initial system modified by localized **specialization**" (1968, p.87).

According to K. BOULDING: "Some growth **phenomena** can be dealt within terms of relatively simple **population models**, the solution of which yields growth curves of single **variables**. At the more complex **levels** structural problems become dominant and the complex **interrelationships** between growth and **form** are the focus of interest. All growth **phenomena** are sufficiently alike however to suggest that a general theory of growth is by no means an impossibility". (1956, p.13).

Forty years later, we still lack such a systemic theory!

1475

GROWTH ALGORITHM (LINDENMAYER's)²⁾

An algorithm for construction of a **tree** that can generate one-dimensional **sequences**, but also apply its **rules** in several places simultaneously (After C. EMMECHE, 1994, p.74)

The algorithm is **recursive**, i.e. it functions as a programmed **rewriting process**.

EMMECHE comments that it "...can be viewed as a series of recipes or algorithms for the creation of the parts of a plant" (Ibid).

The "**trees**" thus constructed are more or less **self-similar**, which explains why many plants tend to develop a **fractal** disposition of their parts. The **models** thus generated can be made more realistic by introducing some **randomness** in the algorithm.

1476

GROWTH (Allometric)^{2) - 4)}

"The relation of the growth of a **part** or **organ** to that of the whole **organism**" (C.R. REEVE & J. HUXLEY, in HUXLEY, 1972, p.267).

This relation corresponds to the formula $y = bx^a$ or $\log y = \log b + a \cdot \log x$, given by C.R. REEVE and J. HUXLEY (Ibid). R. NAROLL and L.von BERTALANFFY showed later on that the allometric growth relation can also be applied in sociology and gave some examples, as follows:

- number of services establishments, factories and retailers in relation to urban population.
- differentiation between specialized trades in relation to population.
- urbanization in relation to total population (1956, p.76-89).

It should be noted that different **trends** may appear during the allometric growth **process**. They are probably related to differential acceleration and saturation factors which intervene at different times, particularly in **logistic** growth.

1477

GROWTH and STABILIZATION ¹⁾

St. BEER writes some curious and stimulating reflexions about growth: "...any organic seminal **programme** that inaugurates and controls growth 'knows when to stop'. This capability applies not only to the macrostructure, so that you and I are roughly the right size to be recognizably human: it also applies to the infrastructure of the **organism**: every limb, every **organ**, every parcel of tissue however delineated, from cranium to toe-nail, grows to a **limit**. During growth, further growth is by definition due to follow: **development** (except by massive intervention from outside) cannot be arrested until the plan is complete. To this extent, a partly grown **organism** is in an improbable **state**, and is driving towards its most probable **state** – adult completion. Growth can be regarded, that is to say, as an *entropic process*. The growth **process** stops when the genetic **information** is used up, actually having been finally and in sum exchanged for potentiality... Growth, then, is a **self organized activity** of a system in which that system 'learns to be what it is'" (1968, p.360-1).

In other words:

1. Growth is within each individual system the actualization **process** of an **archetypical algorithm**.
2. Growth leads inevitably to **organizational closure** and **autopoiesis**.
3. It leads as well to mature **homeostasis**, i.e. **dynamic stability**.
4. The original **archetypical** "seed" must contain an implicit potential (whatever this may mean) for **constraints** construction, probably operated through **interactions** and **connections** between its original **elements**.
5. It must contain coordinated **loops** of **self-reference** which guide the system along a typical **chreod**.

1478

GROWTH and STRUCTURATION ¹⁾

In his paper on the possibility of a general theory of growth, K. BOULDING underlines the necessary and unavoidable relation between growth and structuration.

He shows how the necessity to maintain a sufficient **input** of **resources**, as well as their **distribution** in a growing system implies also a growing **differentiation** of its **structures** and, for each functional **structure**, the need to subdivide (1956, p.71).

He uses as an example school buildings: "A one-room schoolhouse, like the bacterium, can afford to be roughly globular and can still maintain effective contact with its **environment**" (Ibid). It can receive, for example, light from its four sides. Should the school include various classrooms, it will have to be lengthened, in order to provide some light to every room. If it is still larger, internal **structures** for **communication** (lobbies, a telephone system, etc...) become necessary. It will possibly take the classical form of a comb, or create alternative internal subsystems providing light, power, heating, cooling, etc... The only alternative solution should be several separate buildings in a campus.

The alveolar or **fractal** aspect of many biological **structures** illustrates the same **phenomenon**.

1479

GROWTH (Autocatalytic) ²⁾

"A **positive feedback process** that augments the static **variety**, with the only **constraint** that the added systems belong to the same general type that "fits" the **template**" (F. HEYLIGHEN, pers. comm., p.15).

This concept seems to be specifically useful for **populations**. HEYLIGHEN gives as an example the **process** of crystallization, where the concept of **template** applies easily.

In the case of **living systems** the concept of basic type or **archetype** corresponds to the one of **template**: the number of members of a species increases, but they remain true to type, i.e. no new species does appear.

1480

GROWTH CENTER ²⁾

The apex or extremities of the system or some other limited sectors become its centers or poles of growth.

It seems that the possibility of more or less free **interactions** between an extremal **zone** of the system and its **environment** is a stimulating condition.

However, the **compatibility** of the new **structures** and **functions** abuilding with those already in existence is by no means guaranteed. This may then produce:

- a fission or split, which may lead to the **segregation** of a **part** of the system and, possibly to the genesis of a new system.
- an internal reorganization which may lead to an important modification of **objectives**, internal **structures** and **functions** or even of the very **identity** of the system.
- the suppression by the systems **controls** of the new **parts** or **elements**, seen as undesirable or dangerous.

1481

GROWTH CURVES ²⁾

Growth is a very general feature of **processes** and systems. It has however also quite diversified characteristics in different cases.

The following listing is a selection of the most useful growth curves related to specific types of processes:

1. Asymptotic: permanently slowing down growth
2. Chreodic: periodic (fluctuating) growth within a growth **trend**
3. Exponential: permanently accelerating growth (i.e. explosive)
4. Lineal: constant arithmetic proportional growth
5. Logarithmic: **exponential** growth defined by a characteristic exponent
6. Logistic: an accelerating growth phase preceding a decelerating growth phase, due to a **negative feedback**
7. Normal (Gaussian): statistical distribution (Bell shaped curve) that can also represent a growth and **decay** sequence
8. Periodic: fluctuating growth or dynamic **oscillations** around a median. Frequently superposed on another curve
9. Semi-logarithmic: growth expressed in percentages (**ratio scale**)

Without being a growth **phenomenon**, celestial bodies orbits are also described by geometric curves in the **time** dimension. they can be hyperbolic, parabolic or elliptic. In this case, they are periodical, but their **periodicity** may be variable and unstable

→ **Chaos; Criticality (self-organized; chaos, curve (Involving); Cycles; Fourier analysis; Power laws; Self similarity in the Weierstrass function; Vortex**

1482

GROWTH (Differential) ²⁾

The various **parts** of a system may grow at different **rates**. As a result a very considerable **variety** of **forms** may appear.

D'Arcy W. THOMPSON (1916) showed that at any time the **form** of an **object**, an **organism** or an **organization** is the necessary result of the laws of its growth, until that moment. K. BOULDING expressed this as follows: "Anything which is growing uniformly will become a sphere. That which grows more rapidly in one direction will become long and that which grows more quickly on one side than on the other will twist into some sort of spiral" (1956, p.72).

1483

GROWTH (Directional) ²⁾

That growth be generally unequal in different directions is a basic condition for differentiation.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

One cause of directional growth is expressed by C. ZELLER: "Growth becomes directional if, on one side of a minimal **aggregation** unit, free **elements** are more readily available than on the other sides" (1967, p.54).

ZELLER also states: "With the initiation of **asymmetric** growth, ... a plan of **development** of the **aggregate** is laid down" (p.55).

This is the **environmental** cause of directional growth. It is difficult to pinpoint internal conditions of the growing system that may lead to the same **trend**, but their existence is doubtless, at least in biological and **social systems**. Internal **asymmetric** growth is probably related to the different **levels** of **energy flows** and of spatial **substrate** available for **subsystems** at different times.

M. MARUYAMA's **models** of **deviation-amplifying processes** illustrate the subtle **interactions** of **rules**, as applied on **initial conditions**, which lead to directional growth.

1484

GROWTH (Divergent)²⁾

A mode of growth related to the **FIBONACCI series**, for example in vegetals.

Divergent growth is a radial movement from a center towards periphery. It reflects a logic of **space** occupancy through the **time dimension**.

The result is a progressive structural construction through **iteration**: The **time dimension** is reflected in **helical forms**. The growth ratio responds to the so-called **generative helix**, characterized by a **divergence** angle, which remains constant during growth.

In most cases, the subjacent **rules** of growth seem to respond to **FIBONACCI series** and produce spiraled **forms**, which probably result from intertwined **energy fields**, rooted at the physico-chemical **level**, in accordance with TURING's concept about "The chemical basis of **morphogenesis**" (1952).

The rate of growth, which is **nonlinear**, is under two **constraints**: one corresponds to **energy inputs** and the other to the limitation of available **space**. As a result, **space** occupancy takes place on a **space-time** curve akin to a geodesic. (In vegetals, converging towards the apex).

In plants, the limited **space** available for growth is defined by a fraction consisting of **two FIBONACCI series**: one as numerator, the other as denominator.

Divergent growth, as a mode of **space** occupancy, could probably be usefully researched in many other disciplines.

1485

GROWTH (Explosive or Exponential)^{1) - 2)}

The characteristic of a growth **phenomenon**, **process** or **rate** constantly submitted to a **positive feedback**.

Any system affected by this type of growth is quickly running toward its destruction, because it is using up evermore growing quantities of some specific **resource** obtained from its **environment**, until the moment the **resource** becomes scarce and insufficient to maintain the rapidly growing **structures** of the system.

According to K. BOULDING's (himself an economist) barbed comment: "Anyone who believes that exponential growth can continue indefinitely in a finite world is either a madman or an economist" (1973, p.92).

As stated by J. MILSUM: "The basic growth **process** is of necessity escalatory or **unstable**, at least over a reasonable working **range**" (1968, p.27).

Such **situations** are very dangerous as they are generally not clearly perceived until the terminal **runaway process** is well on its way and cannot anymore be stopped. A dramatic **collapse** becomes then unavoidable.

This type of **runaway** growth is frequently observed in some physical **phenomena**, in ecology, in man-made disasters, in financial panics and in economics, as for example hyper-inflations.

Their early detection and avoidance could be one of the most important contribution of cybernetics and systems to practical activities in general.

1486

GROWTH (Limits to)^{1) - 4)}

1. This is the title of the famous first report to the **Club of Rome** (1972), which concluded that the limitless demographic and economic growth of mankind was an impossibility and would necessarily lead to a crash within a (historically) very short **time**. (D.H. MEADOWS et al., 1972).

This work led to massive controversy, for a number of quite different technical, conceptual and political reasons. The technical ones were related to the construction of the **model**, based on the specific ways of use of FORRESTER's **systems dynamics**. More than 20 years later, this debate is still not settled (See D. MEADOWS et al: "Groping in the Dark", 1982, and subsequent comments).

The conceptual reasons are principally about the real possibilities to define which **data** are relevant, to obtain sufficiently reliable ones on a sufficient **time span**, and even the possibility to construct any such complex **model** with a real predictive power.

The political reasons are related to the premises selected by the authors of this **model** (and the subsequent ones) referring to the needs and hopes of different human groups in the world.

In any case, the basic concept is about the impossibility to pursue an illimited (and nowadays exponential) demographic and economic growth. MALTHUS may have been mistaken for two centuries, but he probably won't be forever.

See "Growth (explosive)"; "Growth (Logistic)"; "Growth and stabilization"; "Growth (Rate of)".

2. A deeper interpretation of limits to growth has been proposed by K. BERRIEN: "... systems... are limited in their **variability**; hence, **adaptations** also are limited. It is not possible for a system to adapt to everything. It is this limitation in **adaptability** that prevents a system from growing to infinite **size**. Thus, institutions as they grow, face, among other problems, one of internal **communication**... The system ceases to grow, partly because it is unable to adapt to the internal **integration** problems of further growth" (1968, p.80).

This may be the deepest available explanation for **hierarchy** in **sociality**: beyond some limits at a defined **level** of **complexity**, growth becomes impossible. It can however be resumed if a number of systems at that **level** integrate themselves into a system of higher **level** of **complexity**.

1487

GROWTH (Logistic)^{1) - 2) - 4)}

Logistic growth **processes** are characterized by the progressive limitation of growth due to a **saturation** factor, *which is directly proportional to growth itself*.

The acceleration of growth *precedes* the acceleration of the **saturation process**. Growth tends thus to look firstly **exponential or logarithmic**, but will generally slow more and more down as the growth **process** goes on. The alternative is destructive **runaway** or **explosion**.

In J.H. MILSUM's words: "... the decay of the growth **rate** essentially follows a mirror image **pattern** to the initial increase of growth **rate** until a **steady-state population** is reached, typically under a constant nutrition condition" (1968, p.43).

The implicit character of the **saturation process** at its beginning, makes it difficult to perceive before it is already in full swing. This is a dangerous **situation**, specially in relation to many growth **processes** triggered by man, for which the **saturation** factor is not yet perceived.

Serious problems could surface later on (climatic, demographic, ecological and the like). Besides, the most swift **processes** of growth are also the most exposed to violent braking **processes**.

1488

GROWTH (Nonlinear)²⁾

Any type of growth in which the **outputs** are not in an arithmetic relation with the **inputs**.

The relation can be logarithmic, exponential, logistic, asymptotic, etc...

For sound **predictability**, it is important to take the specific type of nonlinearity in account in any **extrapolation**; or to reckon one's uncertainty about the type of nonlinearity.

1489

GROWTH OVERSHOOTING^{1) - 2)}

The **process** by which a system overpasses grossly its optimal dimensions.

A system can remain **dynamically stable** only if two basic conditions are fulfilled:

- the **level** of its **energy** supply is permanently adequate, and
- the **waste** it produces must be disposed of and assimilated by the **environment** at a sufficient **rate**.

These conditions are not always present. When the **energy** supply is over-abundant, the system (specially **populations**) may grow in excess up to a non-permanently sustainable **level**. Worse still, this generally increases **waste** production and can make it unassimilable by the **environment**, in which case the system may asphyxiate in its **waste**.

The main problem here is that many systems also suffer of the effects of a **time-lag**: the nefarious **side effects** are not perceived until they become overpowering and in some cases an irreversible destructive **situation** develops.

This is probably a danger that presently threatens mankind under various disguises.

1490

GROWTH (Principle of autocatalytic)^{1) - 2)}

"Stable **configurations** that facilitate the appearance of **configurations** similar to themselves will become more numerous" (F. HEYLIGHEN, 1992, p.4).

HEYLIGHEN readily admits that this principle is self-evident. However, he adds that it "... describes as well biological **reproduction** as the **positive feedback** of **nonlinearity** characterizing most inorganic **processes** of **self-organization**, such as crystal growth. The principle simply states that it suffices for a **configuration** to be **stable**, and in some respect autocatalytic or **self-replicating** in order to undergo a potentially explosive growth" (Ibid).

In any case, autocatalytic growth is possible only if the following conditions are fulfilled:

- The substrate or **environment** must be able to supply the needed material and/or energetic **resources** for growth;
- A **template** for **self-replication** must be present.

Besides, growth remains unchecked only as long as the **environment** does not become overexploited or supersaturated.

1491

GROWTH (Semi-logarithmic)²⁾

A form of growth that remains constant over time in percentage terms.

The semi-logarithmic scale **representation** is very significant because it shows that an arithmetical growth, even when accelerating, can be merely a constant one in relation to the basic evolution of the **process** considered.

The **ratio scale** should be used to represent semi-logarithmic growth.

1492

GROWTH: Quantitative or qualitative^{2) - 4)}

According to D. KATZ and R.L. KAHN: "The basic type of system does not change directly as a consequence of expansion. The most common type of growth is a **multiplication** of the same type of **cycles** or **subsystems** - a **change** in quantity rather than in quality" (1969, p.98).

This mode of growth has been confirmed for numerous **populations** and **social systems**, in which the proportions of the different **groups** remain constant.

"Qualitative **change** does occur, however, in two ways. In the first place, quantitative growth calls for supportive **subsystems** of a specialized character, not necessary when the system was smaller. In the second place, there is a point where quantitative **changes** produce a qualitative difference in the functioning of a system" (Ibid). Indeed, problems caused by a growing **density**, by longer **communication** lines or **channels**, modified **morphological** relations, etc... do appear and impose the **emergence** of **subsystems** of **support**, **coordination** and **control**.

The present **multiplication** of new types of **subsystems** for specialized services in **human systems**, due to their enormous quantitative growth is a quite typical example.

1493

GROWTH RATE^{1) - 2)}

The relative speed of growth by time unit.

According to K. BOULDING, every system has an optimum or equilibrated rate of growth. He adds: "... (a) higher or lower growth rate may seriously disturb the functioning of the system, even to the point of its **collapse** and "death". (1956, p.74).

BOULDING gives some examples from botanics and economy. Such abnormalities are obviously very frequent and could be generally named "*disturbances of growth rates or rhythms*". They seem to be linked to **disruptions** of the **equilibrium** between the relative

growth of various **functions** and **structures** (or **subsystems**), induced in some cases by internal causes and in other by **environmental** factors.

This **phenomenon** has been reported in quite different fields as, for example, in human biology, physical and mental **lags** because of a deficient alimentation during childhood; or in **management**, a crisis of general disorganization provoked by an excessive rate of growth.

Referring themselves to GOETHE (the so-called "Budget Law") and Geoffroy de SAINT-HILAIRE ("Loi de balancement"), R.S. NAROLL and L.von BERTALANFFY write: "...in an **organism**, there is a characteristic and constant "**equilibrium**" between the **organs** and, as we may add, the chemical **components** as well. So **overdevelopment** of one **part** will be corrected by lack in an other **part**" (1956, p.79).

The subject is thus at the same time closely related to **allometric growth**.

K. BOULDING again writes: "Growth at any rate... cannot take place without the **organism** eventually becoming "large" and diseconomies of **scale** may set in. The ideal rate of growth, therefore, may properly be regarded as a diminishing **function** of the **size** of the **organization** and will eventually diminish to zero" (1956, p.39-40).

This affects **organisms** as well as **organizations**, and probably explains the very general transition of systems of many types from growth to **dynamic stability**. It could also be the basic reason why individuals of any type, limited in **size**, tend to socialize and form more **complex systems** on a higher **level of organization**.

1494

GROWTH-RATE PARAMETER²⁾

The factor which controls **growth rate**.

Since no growth **process** is independent of its **environmental** conditions and/or intrinsic characteristics, none can be **linear** at **long-term**. This must be reflected into growth equations if real **situations** are to be satisfactorily modelled.

Thus a growth-rate parameter must be introduced into the equation.

According to J. GLEICK: "In the physical systems from which these equations were borrowed, that parameter corresponded to the amount of heating, or the amount of friction, or the amount of some other "messy" quantity. In short, the amount of **nonlinearity**" (1987, p.63).

R. JENSEN uses as an example a very simple difference equation:

$$x_{n+1} = ax_n(1-x_n) \text{ or } x_{n+1} = ax_n - ax_n^2$$

He writes: "The **time-evolution** of x_n generated by this single algebraic equation exhibits an extraordinary **transformation** from **order** to **cha-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

os as the parameter a , which measures the strength of **nonlinearity** is increased" (1987, p.170).

For x included between 0 and 1 and for different values of a , JENSEN distinguishes the following cases:

- for $a = 1$ - Growth followed by monotonic damping and extinction;
- for $a = 2,9$ Growth toward an **asymptotic stability** with a punctual **attractor** (variable according to the value of a);
- for $a = 3,2$ Growth followed by **fluctuations** around a **stable cycle limit**;
- for $a = 4,0$ Growth followed by apparently **random fluctuations (chaos)**.

For a clearer understanding, see reference.

1495

GROWTH REGULATION¹⁾

Numerous authors have observed that growth is in general in no way an anarchical **phenomenon** in systems.

The most frequent model is **logistic growth**.

C. WADDINGTON, for example, showed that growth goes with **fluctuations** around a basic **trend**, within a kind of guiding **channel** which he called a "**chreod**".

However the precise mechanism and fundamental cause of growth regulation are still ill understood.

All systems seem to count with internal **norms** relative to their global and maximal **dimensions** as well as those of their different **subsystems**. But it is quite difficult to pinpoint the **elements** or groups of **elements** which are the bearers of these **norms** and how they command their more or less strict observance.

Moreover, while **fluctuations** are a result of the need to maintain the global and local **equilibria** of internal **structures** and **functions**, they are also correlated to **environmental variations**, significant for the system (as for example the seasonal growth of plants or the acceleration or deceleration due to climatic **variations**).

See for ex.: **Circadian rhythms**

1496

GUESS²⁾

"A question which can be answered by "yes" or "no" (A. RAPOPORT, 1966, p.6).

This is a very useful notion for the evaluation of the **quantity of information**.

A. RAPOPORT explains: "It can be easily seen that a number from one to one hundred can always be guessed in seven guesses, while a number from one to one million can always be guessed in twenty guesses. To do this one needs to make guesses in such a way as to eliminate one half of the remaining **range**. In the case of a million, one starts with: "Is it less

than 500.000 ? If yes, "Is it less than 250.000 ?". If no, then is it less than 375.000 ?", etc. Since one million is less than 2^{20} , it will take at most 20 such **dichotomies** to determine the number" (p.6).

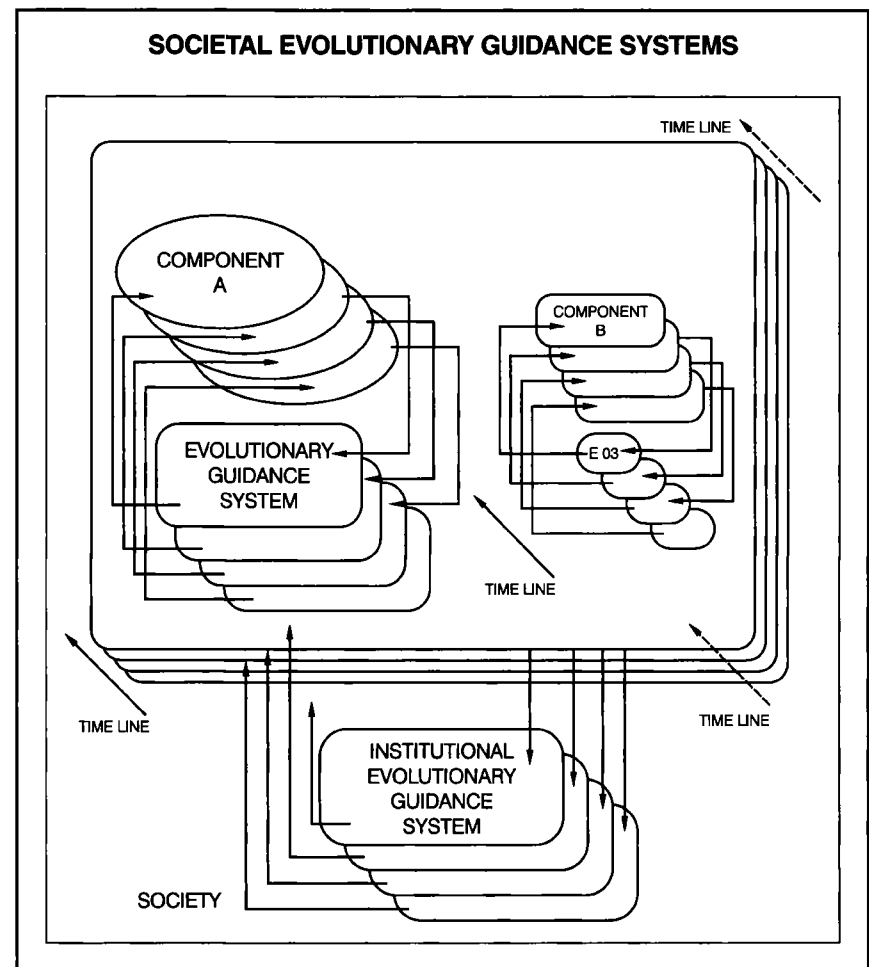
1497

GUIDANCE (SELF-) ⁴⁾

T. GOGUEN FRANTZ proposes what she calls "evolutionary guidance systems (EGS's)", which can help persons "to **design the organization** they ideally would like to become at some time in the future..." on the base of "an **image**, clear enough, attractive enough..." and eventually "**consensually agreed upon**" (1991, p.79).

FRANTZ adds (describing the **graph** shown in her paper): "EGS's must keep the **image** vivid for everyone and must keep it updated. For that reason iterative **cycles of information** are shown flowing from a past or present institutional **state** to the EGS and from it to a future **state** of the institution. Multiple **states** are

Figure: see entry **GUIDANCE (SELF-)**



Guidance (Self): an example

From T. GOGUEN FRANTZ: 1991, p. 78

shown for the EGS, because it co-evolves with the system it serves" (Ibid).

This is an interesting idea, which may be very helpful to psychically mobilize people. However, some caveats seem to be necessary. No EGS could suddenly appear out of the blue: it is unavoidably based on **values** and **norms** (how things *should be*), which are not neutral, being in the best case, culture-borne.

An EGS could however also be shaped by some ideologues (individuals or closed knitted **groups**), whose well known insulation from anything that may contradict their beliefs makes them good candidates for inquisition, intolerance and autocracy, at times even cloaked in a pretense of open mindness.

Systemic guidance should imply a maximum possible genuine **openness**, which is the only way to insure that the quota of **invisibility** is as low as possible.

True guidance should be based on mental devices for taking a clear conscience of one own's basic **values** and **norms**, and for their **evaluation**. This implies taking distance from oneself, one of the most difficult psychological exercise, for sure.

At least, some systemic concepts may help as for example **semantic** critique (KORZYBSKI) or the notion of **mindscapes** (MARUYAMA).

H

1498

HABIT ⁴⁾

Any **pattern** of **behavior** acquired through **imprinting**, **training** or **learning**, and more or less definitively fixed.

According to C.S. PEIRCE, repeated **inferences** are leading to the establishment of a habit (U. ECO, 1979, p.17).

Habit formation in turn is the way to **algorhythmization** and subsequent **automatization** of **behaviors**. G. BATESON states that it: "...is a major economy of conscious thought" (1973, p.115), as it applies to "... the solution of *classes* of problems" (p.245). Moreover, the necessary parsimony in the use of neural **circuits** implies that: "No **organism** can afford to be conscious of matters with which it could deal at unconscious **levels**" (p.116). This is true for man. On a lesser mental **level**, it is also true for animals, as shown by J.von UEXKÜLL and G. KRISZAT (1928, 1934), K. LORENZ and other **ethologists**.

Habit formation is a progressive **process**. It is easy during infancy, less so during adolescence and quite more difficult in adult age, probably because it must be a **process** of **connections** formation in the **brain's neural network** and in adult age, frequently a **process** of replacement of existing **connections**.

As to the unconsciousness of habits, BATESON observes "... that the "unconscious" includes not only repressed material but also most of the **processes** and habits of **gestalt perception**" as we are "... unable to say clearly how this **pattern** was constructed, nor what clues were used in our creation of it" (p.272).

1499

HABIT EXTINCTION ⁴⁾

The spontaneous or willful elimination of a habit.

A habit may spontaneously disappear if it is not more or less frequently reinforced. However, it seems that basic habits acquired early in life never disappear definitively, even if the **organism** is unaware of their survival.

The willful elimination of a habit requires a considerable effort of conscious deconditioning, and retraining if it is to be replaced by another habit. Such a **process** is generally impossible at the physiological **level**.

At the psychological and mental **level**, it is still quite difficult and can be painful as stated by G. BATESON: "... Any freedom from the bondage of habit must also denote a profound redefinition of the self" (1973, p.275).

The different degree of resistance of habits to **change** seems to be related to the relative paleontological antiquity of the different **brain structures**, as they were formed.

The study of habit formation and extinction in learning **automata** will probably teach us much about habits in **living systems**.

1500

HABIT FORMATION ⁴⁾

The progressive acquisition of fixed mental **patterns** and **behaviors** through **imprinting**, **training** or **learning**.

From the physiological viewpoint, recent research seems to indicate that habit formation and retention take place in "two fundamentally different **learning** and retention systems. These systems use different circuitry within the **brain**, store different aspects of experience and follow different **rules** of **storage**" (H.L. PETRI and M. MISHKIN, 1994, p.36). The **brain** seems to be a **network of networks**. This is important for the **understanding** of our normal as well as pathological mental **processes**.

Habit formation presents various aspects:

- 1) It is based on experimental recognition of repetitive **situations** or **patterns**.
- 2) it supposes the **perception** of at least a degree of coherent **complexity** (through appreciation of recognized **Gestalten** and their **contexts**).
- 3) it implies the progressive **stabilization** of specific and coordinated neural **feedbacks** in **nets**.
- 4) it becomes efficient by **compression** of **redundant data** into standardized **perceptions**, shaping of **mental maps** and of totalizing **concepts**.
- 5) it supposes the substitution of "... a deeper and more enduring change for a more superficial and reversible one" (1973, p.321).

In G. BATESON's words: "The **phenomenon** of habit formation sorts out the ideas which survive repeated use and puts them in a more or less separate **category**" (p.477).

This is also true for behavioral habits.

1501

HABIT INTERFERENCE (Principle of) ^{2) - 4)}

"Old **memories** interfere with the acquisition of new ones" (K. BERRIEN, 1968, p.81).

BERRIEN gives examples: "A tree that is bent by the prevailing winds to the east will snap off if forced in the opposite direction. An **organization** developed to sell automobiles is not likely to grow by gradually taking on the sale of road-making machinery" (ibid).

BERRIEN was probably unaware in 1968 of the **autopoiesis** and **organizational closure concepts**, which explain why habits tend to block the acceptance of novel ways or **behavior**.

1502

HABITAT ¹⁾

"The sum of **environmental** conditions in a specific place occupied by an **organism**, **population** or **community**, where it naturally grows and lives" (UNESCO - UNEP glossary of **environmental** education terms - 1983, p.16).

This term is mostly used in **ecology**, including human **ecology**.

1503

HABITUATION ¹⁾

A very simple form of **training** through which a **living system** subjected to repeated **stimuli** tends to produce diminishing **responses** (after W.R. ASHBY, 1960, p.189).

Habitation is primarily a property of **neural** systems. It "consists in the weakening of existing (wired-in) synaptic **connections** with repeated **stimulation**" (M. BUNGE, 1979, p.163).

According to ASHBY this **behavior** "...is to be expected to some degree in all **polystable systems** when they are subjected to a repetitive **stimulus** or **disturbance**" (ibid).

This of course, is true only if the **stimulus** or **disturbance** is non-destructive, or so dangerous that it elicits other types of **reactions** (as for example fighting or escaping).

It would be interesting to verify if **artificial organisms** could be trained in this way.

1504

HABITUS ⁴⁾

The structural and permanent basic result of **training** in the trained individual.

An example is the pianist, who becomes a good interpreter only after having acquired the basic automatism of piano play.

At a second **level**, improvisation or composition become possible only after the basic **codes** and styles of music have also been incorporated.

Of course both **levels** of **training** are different for other instruments as for example violin, or clarinet. They also differ in distinct types of music, as for example in jazz or in indian ragas.

More generally speaking, any trade is necessarily grounded in some specific habitus.

Habitus is transmitted within specific **socio-cultural fields**.

1505

HALTING PROBLEM²⁾ - 3)

TURING demonstrated by his **uncomputability theorem** that there is no effective mechanical procedure for deciding whether an arbitrary **program** will ever finish its computation and halt.

G. CHAITIN thus parallels TURING'S work with **GÖDEL's incompleteness theorem**: "Kurt GÖDEL, the Austrian logician and Alan TURING, the father of the computer, showed that it is impossible to obtain both a consistent and complete axiomatic theory of mathematics and a mechanical procedure for deciding whether an arbitrary mathematical assertion is true or false, or is provable or not" (1990, p.44).

CHAITIN himself connected both aspects of this intrinsic limit to logical systems **validation** through his concept of **algorithmic incompressibility**.

According to J. CASTI: "... since the two problems are logically equivalent, the fact that the Halting Problem has no solution implies that the **Decision Problem** is also unsolvable. So we run up against a brick wall in trying to get to the heart of things by following a set of **rules**" (1990, p.137).

Of course, more or less provisionally and satisfactory solutions of any practical **decision problem** still remain possible. But we should always be aware of their **limits**.

1506

HAMILTONIAN SYSTEM²⁾

A system whose study is amenable to Hamiltonian mechanics.

Hamiltonian systems are governed by Hamiltonian **dynamics** i.e. in R. THOM's words "A **dynamics** where there is no **energy** lost through **dissipation**" and as a result "the look of **trajectories** is not notably modified" (1993, p.41).

M. FARGE writes: "Hamiltonian mechanics deals only with **stable states**, or **close to equilibrium**, and describes only conservative, i.e. reversible **phenomena**, while turbulent **flows** are highly **unstable** and **dissipative**, i.e. **irreversible**; moreover classical **dynamics** always started from systems with few interactive **elements**, without a great number of **degrees of freedom**" (1992, p.212).

Only **homeostatic systems** are amenable to Hamiltonian mechanics, because in G. NICOLIS words they: "admit a **variety** of conservation laws, **constraining** their **evolution** very strictly". But "as a counterpart they present rather poor **stability** properties in the sense that their **evolution** remains strongly dependent on the **initial conditions**" (1981, p.188). In other words, they are tightly **deterministic**. **Dissipative, bifurcative** systems are **unstable** and non-Hamiltonian. Note the correlation with POINCARÉ's **3-bodies or n-bodies problem**.

Now that **deterministic chaos** and **dissipative structuration** have been discovered and researched, it becomes obvious that Hamiltonian systems and **dynamics** are rather abstract and theoretic **models** of not so common systems or very simplified ones.

1507

HAMMING DISTANCE²⁾

"A measure of dissimilarity between **patterns**" (P. DENNING, 1989, p.333).

This measure is expressed as the number of **bits** in which the considered **patterns** differ. DENNING offers a very simple example: "... the distance between 01100 and 10110 is 3 **bits**" (Ibid).

1508

HANDICAP²⁾⁴⁾⁵⁾

The relative **cost** advantage or disadvantage of producing a **signal** or an **output** in relation to the **level** of **resources** available to its **transmitter**.

This apparently abstract definition widely applies among animals and humans. "In 1982, evolutionary biologists W. HAMILTON and M. ZUK proposed a new handicap hypothesis that forged a **link** between the quality of individuals and their sexual **signals**... In essence, only males with genes for, say, parasitic resistance would be in prime condition and thus able to express the best sexual **signals**" (M. WALKER, 2000, p.23). WALKER observes that, in more subtle ways, this is even true for human males.

Based on this observation, A. ZAHAVI proposed what he calls the "handicap principle", which is in essence a quite general evolutive **selection mechanism** (Ibid).

In human societies at different **levels**, the validity of the handicap principle is also probable. Powerful **organizations**, with an abundance of available **resources**, are able to resist strong **perturbations**, and to promote themselves in a more efficient manner.

1509

HARDWARE⁵⁾

"The mechanical aspects of a computer, excluding the **set** of instructions given to the coomputer by the programmer (called Software)" (T.F.H. ALLEN & T.B. STARR, 1982, p. 269).

1510

HARMONIC ANALYSIS→ **Fourier analysis**

1511

HEBB'S RULE²⁾

"...a synaptic **connection** that is used often will increase its strength so that the probability that it will be used later on increases".

This rule, quoted by F. HEYLIGHEN (1990b), may seemingly be extended to any type of **learning network**, able to learn by experience. It is however ambiguous, since it may lead the **network** into a rut, as in Pavlovian and Skinnerian conditioning.

St. KAUFFMAN describes this situation: "... a difficulty with most versions of the Hebbian synapse is that the system tends to dig itself into a Hebbian hole deep in the solid **regime**. **Attractors** tend to become too deeply grooved into the system. This **embedding** may inhibit flexible **learning** by trapping the system too readily in suboptimal **responses**" (1993, p.229).

This could be called the *grooving* problem and its possible relation to **organizational closure** should be investigated. This could even be significant in **social systems**.

1512

HELIX^{1) - 2)}

The **trajectory** in **time** of a cyclical **process**.

The helix can be cylindrical, or conical.

A cylindrical **trajectory** corresponds to **dynamic stability** of the **function** or system thus modeled. The conical helix (i.e. the spiral) when opening, corresponds to an expansive **process**, that may eventually end up in a **run-away event**. The closing helix indicates a trend toward **asymptotic stability**.

Ch. LAVILLE showed that helices are brachystochronic **trajectories** in a **vortex**, i.e.: "... the **trajectory** corresponding to the highest velocity or the least energetic expense... joining the starting point and the terminal one" (1950, p.51).

This explains the relative predominance of helicoidal movements and **forms** in nature, in relation with the least possible production **level** of **entropy** in **dynamically stable systems**.

H.C. SABELLI states that the helix is a **representation** of dialectic movement: "... because **evolution** has two components: 1) a **reversible change** in which thesis and antithesis symmetrically negate each other and the synthesis represents a return to the thesis, following its definition as a negation of the negation; and 2) a non-reversible **process** for which all three stages represent a movement in the same direction" (1994, p.353).

→ **Vortex**

1513

HELLENIC SYSTEMS SOCIETY¹⁾

The Greek Systems Society was founded by M.DE CLERIS and a number of Greek systemists.

It has published a **Systems Handbook** in Greek.

It also organizes tutorials and international meetings, notably in Creta. It is member of the IFSR and of the European Systems Science Union.

1514

HERD EFFECTS ¹⁾²⁾⁴⁾

The protective effects for individuals resulting from congregation in considerable numbers.

Such effects can be observed in numerous different animal species: fish **shoals**, nesting birds, gregarious mammals, insects flights, etc...

Those individuals at the center of the herd are better protected because they are completely surrounded by individuals of the same species which are not dangerous to them. The peripheral individuals are more at **risk** because, on the outer ring, they are in direct contact with the **space** of possible predators. In most cases "insiders" and "outsiders" rotate, which is globally efficient for the whole flock.

Observing nesting birds, Diane BRUNTON (Yale University) discovered that the central area is at a disadvantage when the predator is airborne, thus able to make use of the third **dimension**. In that case, the central **density** of the flock offers increased opportunities to the predator.

(Source: The Economist, Oct. 18th 1997)

→ **Edge effect**

1515

HERD IMMUNITY ²⁾⁴⁾

The resistance to **propagation** of a contagious **process** in a **composite system** when the contagious **element** is insufficiently numerous.

C. WILLS writes: "If most of a herd is immunised against a disease, that disease can no longer spread easily, and the few unimmunised animals are also protected" (1996, p.41).

In more general terms, **avalanches** and other **percolation effects** in **composite systems** occur only if a **critical density threshold** of the perturbing **elements** is crossed.

Herd immunity is related to the degree of **diversity of elements** or **evenness** in the defined space.

1516

HERMENEUTICS ³⁾

The science of interpretation of texts and **symbols**. Originally hermeneutics was concerned with biblical scriptures and philosophical commentaries. It has however been widely extended during the last century, for ex. by DILTHEY (1922, 1935)

Hermeneutics is closely related to **semiotics**, the science of **signs** and their **meanings**

By extension, the science of the interpretation of human individual and social **behavior**.

What people think they themselves are doing, as well as what other people are doing is of course not necessarily the same as what they are "really" doing. The problem is obviously the **meaning** that should be given to the word "really", as it does not seem possible to establish perfectly objective **criteria** for describing "reality". This is specially true in human sciences, in which **values, norms, mental frames**, etc... can never be "**objective**".

J.Z. YOUNG shows himself somewhat skeptical about hermeneutics as a science when he defines it more modestly as "the study of the supposed fundamental significance of human thoughts, utterances, **actions** and institutions" and observes that "Hermeneutics was used originally by theologians for interpretations of the truths in the Bible" (1978, p.293).

Of course, the study of human conditions of **knowledge**...by humans is by its nature always relative and possibly questionable. It is however better than the mere naive uncritical **belief** of an **observer** who does not understand his own defined and limited mental and psychical conditions or, as said by Ortega y Gasset, his belief in his own **transparency** as observer (1965, p. 145)

The German philosopher Hans GADAMER (1900-2002) is generally considered to have founded Hermeneutics (J. GRONDIN, 1995, 1996, 1999). Much of his work has its roots in the pre-socratic greek philosophers, among them Heraclitos and Parmenides.

→ **Autogenesis, Ontological skepticism**

1517

HETERARCHICAL – HOLOGRAPHIC ORGANIZATION ⁴⁾

J. A. JOHANNESSEN who developed this **model** states the following **criteria** as requirements for a heterarchical or holographic organization:

1. The **whole** enclosed in its **parts**
2. **Double-loop learning (deutero learning)**, with **communicative competence**
3. Fewer **levels of management**
4. Liquidation of a centrally managed **command and control model**
5. Transition to a "flatter" organizational **structure**
6. Clearly defined **goals** leading to **action**, where the results, plans and **goals** can be evaluated explicitly
7. More emphasis on individual responsibility for contact and **communication**
8. More emphasis on the overall view
9. Organizational **design** favoring innovations and **autonomy**
10. The gathering of **information** a more distributed **process**
11. The transition from **data** processing to complete informative systems
12. Flexibility and freedom for the individual members of the **organization**
13. Involvement by all in the **planning process**

14. Creating the future, not predicting it

15. Cybernetic principles as the foundation for organizational **design**

16. Self-organizing, **autonomous small groups**

17. Global **information** can be taken out locally and local **information** can be taken out globally.

In holographic terms: each part of the organization contains enough **information** to recreate the **whole**" (1991, p.41-42).

1518

HETERARCHY ^{1) – 2) – 4)}

A decentralized arrangement of **nodes** in a **network**.

This concept was introduced by W. Mc CULLOCH who explained that the **relationships** among the **nodes** may be variable, and even contradictory.

Heterarchy can also be defined as a non-centrally distributed system of **components** with various interconnected focal **elements** in a hierarchical **organization**.

Heterarchy is quite different from the tree-like classical **hierarchy**. Not every **decision** must be here taken or controlled by the top power. Moreover, many **elements**, if not all, are multivalent and may, up to a point, play different **roles** in the system and replace each other.

According to G. WEINBERG, many attempts to use strictly **hierarchical models** are ill adapted to **complex systems** (and particularly, **human systems**), which are more like hybrids of **hierarchical** and heterarchical systems (1972, p.272).

1519

HETEROCHRONY ¹⁾²⁾

A differential **rate of growth** and/or **development** in a living **organism**.

Heterochrony can be understood in two different **meanings**:

- 1) The differential **growth rate** of different **organs** in a living being. For example, in the human species, the head grows more than the rest of the body at the embryonic and fetal stages, but this trend is reversed after the birth.
- 2) The different rate of embryonic development in different species. The German biologist Ernst HAECKEL (1834-1919), comparing embryos of different species during their development, came to the conclusion that, at least in vertebrates, different growth rates produced very different animals from quite similar embryos. His idea that "**ontogeny** recapitulates **phylogeny**" proved later on to be a too simple evolutive principle. (Ken McNAMARA, 1999, p.1-4)

In fact, **neoteny**, i.e. the conservation in adults of embryonic or juvenile biological **structures**, appears to be a truer evolutive **process**. It is also of course related with heterochrony.

1520

HETEROGENEITY^{1) - 2)}

Coexistence in a **complex system** of a number of **subsystems** of different types.

Any **complex system** must carry out a **variety of functions** in order to maintain its **activity**. If **complexity** results of the complementary **association** of numerous **components**, these **components** need necessarily be of different kinds. This may be observed easily in human as well as in biological systems.

Heterogeneity is a sine qua non condition of **complexity** because it allows the **emergence** of **synergies** and increases enormously the system's **variety**, which thus becomes **polyvalent**, its capacity of useful **interaction** with its **environment** being as a result, vastly enhanced.

Heterogeneity expresses itself at various **levels** in most (if not all) **complex systems**: the specialized **components** are generally themselves **complex systems**. J.G. MILLER did demonstrated this in a very thorough manner in his "**Living Systems**" (1978).

A. ANGIAL used the expression "unitas multiplex" which makes perfectly clear the idea of a complex multiplicity within a **whole**, but it never became of common use (1969, p.27).

Heterogeneity grows by **differentiation** processes, as for example:

- MARUYAMA's **deviation-amplifying mutual causal process**;
- BENARD's **dissipative structuration**;
- von FOERSTER and ATLAN's **order from noise**;
- PRIGOGINE's **bifurcations** originated by giant **fluctuations** in **systems far away from equilibrium**.

Its development needs a source of **energy** and an internal **variety** sufficiently wide to be moderately constrained. Unrestricted heterogeneity would lead back to **homogeneity** and to the systems demise. Excess of **constraints** would finally block it, which is another road to destruction.

Heterogeneity also presents a temporal **dimension**: The different **parts** or **subsystems** transform themselves along different **rhythms** and **cycles** in **time**, while these **rhythms** and **cycles** combine to produce a global and generally very intricate **behavior**.

Finally, space heterogeneity as an **environmental** condition favoured the appearance of heterogeneous systems. According to the German biophysicist H. KUHN : "The driving force for the **self-organization** of **matter** is seen in a specific **environmental structure** to be found on the surface of the earth. By this **structure**, which is **periodic** in **time** and heterogeneous in **space**, **evolution** is initiated and driven towards a continuously increasing degree of **complexity** correlated to a continuous expansion of the accessible living **space**" (1976, p.68).

According to S.R. REICE: "Spatial heterogeneity and **disturbance** are interdependent. **Disturbance** creates patches, but **patchiness** modifies and sets the extent of the **disturbance** – that is, the **disturbance** responds to the underlying heterogeneity of the **environment**. Different patch types generate different **frequencies** and degrees of **disturbance** and provide numerous opportunities for **recruitment**" (1994, p.434).

The whole subject is closely related to **percolation** and **criticality phenomena** in **composite systems**: **avalanches**, **flicker noise**, etc.

In a different meaning, M. MARUYAMA widely researched heterogeneity in cultures and states: "In any society, at any time there is heterogeneity of logics among individuals. It is possible to find individuals of any logical type in any culture at any time... Cultural differences consist in the way some logical type becomes dominant and influences individuals of other types. Beneath the homogeneous surface of a culture, there are all individual logical types, hidden, camouflaged or transformed" (1994, p.3).

As observed by MARUYAMA, heterogeneity is in some societies and cultures considered positive, and in others, negative. He argues that heterogeneity could "mean **interaction** for mutual benefit", a view held in some African cultures, as the MALINKE of Western Africa.

The use of the term "heterogeneous" seems subject to some misunderstandings. M. BUNGE writes: "There are no heterogeneous systems (e.g. systems composed of people and values, or books and theories)" (1993, p.214)

This should be correct if we would give to "heterogeneous" the **meaning** of "foreign to", or "not coherent with", or "without **structural** and **functional** relations". An hypothetical living being, constructed from **elements** and **organs** from different and unrelated animals would be heterogeneous in this sense... but could not function, nor survive.

1521

HETEROGENEITY and DECOUPLING^{1) - 2)}

The subdivision of a system into functional **subsystems** is useful in order to isolate the various **subsystems** from many disturbances.

Each **subsystem** must take charge only of some quite specific **disturbances**, related to its **function**, but protects the system as a **whole** against them with an enhanced efficacy.

Such a **decoupling** thus allows for a significant increase of the **global efficiency** of the system.

This acquired superiority of very **heterogeneous** systems over the less differentiated ones is generally obvious and explains possibly the universal trend towards the **emergence** of

more and more **complex systems**, whose **flexibility** and **adaptiveness** is considerably enhanced by heterogeneity. This applies equally to individual systems and to **populations**.

As noted by C. HOLLING, decoupled heterogeneity also enhances systems **resilience**. (1976, p.80-82).

1522

HETEROGENIZATION (Self-)⁴⁾

"The incorporation of many ways of living, working and thinking into yourself" (M. MARUYAMA, 1994, p.38)

MARUYAMA states: "It can occur in material, behavioral, psychological or logical areas. Everybody practises it, at least in the material sphere". He gives as an example, eating French, Italian or Chinese food, at times.

However, he adds: "But self-heterogenization in logics or **mindscapes** types occurs much less frequently" (Ibid).

This would cover the incorporation of different views or feelings in one's own **mindscape**, and could become indispensable for executives of multinational firms transferred from one country to another, whose culture is different.

1523

HETERONOMY^{1) - 2)}

"Condition of a system controlled from outside" (E. SCHWARZ – Glossary, 1993, p.7).

This condition is antinomic to **autonomy**. But of course, no system is either entirely **autonomous**, nor heteronomous. It is this last case, it would simply be a **part** of the **environment**.

1524

HETEROPOIETIC¹⁾

Characteristic of a system or **artefact** designed by men, with some **purpose**.

Heteropoietic systems have an **algorithmic** character, or in other words, they have a very limited **autonomy**, or none at all.

In particular, they are unable to maintain themselves or to modify spontaneously their **activity**. They need to be activated, steered and controlled from outside.

They are not **self-reproducing**, neither as a **whole**, nor as to their **components**. **Machines** in general are heteropoietic.

1525

HETEROSIS^{1) - 4)}

Superior qualities produced by the cross-breeding of different genetic lines in plants or animals.

R.L. MEIER tried to extend the **concept** to social sciences and in this case defined heterosis as "Hybrid vigor as a consequence of acculturative **processes**" (1961, p.110).

Such **processes** consist of "Selective combination of **elements** from both the cultures so that a distinct hybrid is formed, the most prominent example being that of England after the Norman invasion" (p.111).

The numerous challenges produced in *individuals* by a different **worldview** and the need to find adequate adaptive **responses** may be considered as the means for heterosis in clashing cultures.

The subject, unfortunately has not been much researched.

1526

HETEROSTASIS I ⁵⁾

"The artificially induced stimulation of the body **mechanisms**" (H. SELYE, 1975, p.467).

This is the original concept of SELYE, quite different from KLOPF's one (see hereafter).

SELYE explains: "Natural **homeostatic mechanisms** are usually sufficient to maintain the normal **state** of resistance. When faced with unusually heavy demands, however, ordinary **homeostasis** is not enough. The "thermostat of defense" must be raised to a higher **level**. For this **process**, I proposed the term *heterostasis* (from the Greek *heteros* = other) as the establishment of a new **steady state** by treatment with **agents** which stimulate the physiologic **adaptive mechanisms** through the development of normally dormant defensive tissue reactions. Both in **homeostasis** and in **heterostasis**, the *milieu interieur* participates actively" (p.86).

This biological **model** implying **cooperative** help by some outside **element** or system, could probably be translated to psychology and the social sciences (in **groups**, **organizations**, **enterprises**, and **cultures**) with quite more than an **analogical meaning**. Unfortunately, the subject seems to have been generally ignored.

1527

HETEROSTASIS II ^{1) - 2) - 5)}

The "maximal condition" that may be reached by a system (After A. Harry KLOPF, using the neuron as an example - 1972, p.5).

The author understands by "maximal condition" (of a neuron) the difference between "the amount of depolarization (pleasure) minus the amount of hyperpolarization (pain)". He explains: "The solution to the mind-body problem is an identity theory. A neuron undergoing depolarization *is* elementary pleasure; a neuron undergoing hyperpolarization *is* elementary pain. The subjective **event** of the experience of pleasure or pain is identical to the objective **event** of neurons undergoing depolarization or hyperpolarization, respectively" (p.6).

These thesis, quite **behavioristic** and **reductionist** and, besides, semantically expressed in a way contrary to the **non-identity principle**, should be closely scrutinized.

KLOPF generalizes his concept of heterostasis to the **set** of all **living** and **meta-living systems** and concludes his study with the following synthesis: "The evolutionary **process** has established an equivalence between that which has **survival** value and that which is a source of pleasure. Thus, **living systems**, in pursuing heterostasis, participate in three broad categories of actions:

1. self-preserving **behavior** (**maintenance of homeostasis**);
2. species-preserving **behavior** (reproduction);
3. **stimulation-preserving behavior** (**knowledge** acquisition and play).

Recognition that these **categories** represent **subgoals**, pursued only as means to an end (Heterostasis), renders certain aspects of human **behavior** more understandable" (p.64).

1528

HETEROSTAT ^{2) - 4) - 5)}

"A system that seeks (moves toward) a maximal condition while not necessarily ever achieving it" (H. KLOPF, 1972, p.9).

According to KLOPF: "The primary **goal** of animals, including man, is the achievement of a maximal condition (*of excitation*), not the achievement of a **steady-state** condition... The **variable** to be maximized is that of the amount of neural polarization being experienced (which is) defined to be equal to the amount of depolarization (pleasure) minus the amount of hyperpolarization (pain) (p.5)

The author adds the following comments: "Nervous systems are so structured that **homeostasis** is a necessary (but not sufficient) condition for the **maintenance of heterostasis**. This explains why **organisms** vigorously pursue **homeostasis** even while it is not their primary **goal**. That **homeostasis** is a **subgoal** suggests that **survival** may not be as central a concern of **living systems** as has been previously assumed" (p.5).

From a more general viewpoint he considers that "The nature of heterostats is such that they do not cooperate as **parts** of larger heterostatic systems unless they have more positive than negative **reinforcement** to do so" (p.57).

The present example of the difficult ordering of various supra-national systems seems to confirm KLOPF's opinion. It seems thus possible that the growing severity of global planetary **messes** may exert finally a favourable influence.

1529

HETEROSTAT (Elementary) ²⁾

A. Harry KLOPF describes as follows his concept of the "elementary heterostat": (a neuron, an individual in a society, and, generally an active **component** in a **complex system**, that may itself be considered a **homeostat**): "An elementary heterostat derives its power from the

special way in which it utilizes **feedback information**. In the case of **positive feedback** (for example, excitation delivered to a neuron), not only does the **input** enhance the **output** but also the **input enhances the effectiveness of recently active positive feedback loops**. In the case of **negative feedback** (for example **inhibition** delivered to a neuron), not only does the **input** diminish the **output** but also the **input enhances the effectiveness of recently active inhibitory feedback loops**.

In this way, the heterostat not only accomplishes **short-term** modifications in its **behavior** but it also accomplishes **long-term** modifications, thus encoding causal relations and providing a basis for intelligence" (1972, p.61-62).

1530

HEURISTICS ^{2) - 3)}

1. Any kind of conceptual device designed to think about a problem, to uncover so-called **facts**, to better understand **phenomena** and to accelerate the discovery of proofs and **laws**. (from the Greek "eurisko": I Found; famous through ARQUIMEDES' well known exclamation "Eurêka", I found out)

2. "Step-by-step procedures which in a finite number of steps insure that a satisfactory solution to the problem is reached" (J.van GIGCH, 1978, p.204).

van GIGCH compares **algorithms** and heuristics: "An **algorithm** guarantees that the optimum solution is reached. The heuristic leads to a satisfactory solution, not necessarily optimum. Both consist of a finite number of steps... It is important to note the difference between heuristics and **rules** of thumb. A **rule** of thumb usually has no analytical foundation and has been developed on the basis of **intuition** and long-time experience... Heuristics to replace them, will probably start from the **rule** of thumb and develop on the basis of a solid and rigorous analysis of the problem and the factors involved. Heuristics are **methods** "to reduce search" (p.205).

M. BODEN's opinion is different: "Most heuristics are pragmatismal rules-of-thumb, not surefire **methods** of proof. Although there is a reasonable chance that they will help you solve your **problem**, they can sometimes prevent you to do so" (1990, p.53).

Heuristics are used to explore a defined extension of possibilities within a **set** of **generative rules**, i.e. by defining a specific **search space** and **paths** of exploration.

M. BODEN gives as an example the **rules** of chess: "Here the **search space** consists of all the board **states** that could be reached by any series of legal moves. Each legal move involves a specific **action** defined by the **rules** of chess" (p.77).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

However, M. BODEN also observes: "It is one thing to say that people use heuristics to solve **problems**. It is another thing to say that all the challenges facing creative thinkers can be met by applying ordered heuristics to strictly defined **search trees**, in the way that traditional **A.I.** problem-solvers do" (p.111). Heuristics could thus be limitative to *very* original creative thinkers, whose **creativity** could be in producing wider embracing heuristics.

We may be led in this way to "... the need for heuristics for changing heuristics" (p.210).

An interesting generalization of heuristics has been proposed by D.B. LENAT in his program EURISKO (or AM). According to him the same exploration **process** can be used at successive **hierarchic levels** (p.211).

Heuristics include the discovery of satisfactory **rules of inference** and the **selection** of the shortest ones. It follows: "... mainly **intuitive**... principles and depends on the type of theory" (after the A.I. Dictionary of the "Österreichische Gesellschaft für **Artificial Intelligence**", p.15)

According to J.W. SUTHERLAND, "... many of the higher-order **paradigms** ... serve as heuristics, a priori '**masks**' we can wear to lend some tentative **order** to otherwise ill-structured (effectively indeterminate) **phenomena**. As opposed to a theory, per se, which depends for its utility on its apodictical quality (i.e., its ability to be empirically validated), the heuristic makes no pretense to rectitude or allegorical alignment with some specific real-world entity. Rather, it serves merely as a synthetic **construct** which is usually a combination of two distinct **components**:

"A *metatheoretical* component which serves to provide an initial and quite broad **boundary** for analysis...

"The second **component** of a proper heuristic is *algorithmic* in nature: it really involves the specification of the '**rules**' we will use in disciplining subsequent analysis, setting in the broadest way the **criteria** of investigation and **truth**" (1973, p.182-3).

In a quite different sense, statistical **correlations** between some **variables** can be used as a base to search for their significance, as shown by R. MARGALEF (1980, p.118). This could be called "statistical heuristics".

I.G. BLOOR describes the uses of heuristics in **decision-making processes**. He writes: "Two basic versions exist: one where the **method** is unknown or unstructured (**trial and error**) and the **objective** or end solution is fixed, and the other where the **method** is proven or known and the **goal** or solution is unknown... The technique may be used where source **data** do not easily fit into a mathematical or similar **model**" (1987, p.18).

1531

HEXAGONAL SPACE FILLING²⁾ - 4)

W. CHRISTALLER (1933) and A. LÖSCH (1945) gave numerous examples of a tendency to hexagonal occupation of the geographic **space**. As stated by M.L. WOLDENBERG: "These writers recognized that the most efficient shape in terms of accessibility to the center of an area is the circle. Circles, however, cannot be packed into a space without leaving interstices. Hexagons are the polygons which allows the closest packing in an area, consistent with minimizing movement **cost** to a point". Moreover "... the overlap between circles emanating from centers is a minimum for an hexagonal lattice of centers" (1969, p.24).

The existence of a mathematical **set** of the various possible types of **nested hexagonal hierarchies** in the occupancy of space has been demonstrated by LÖSCH. The nested **subsets** can be trapezia, pentagons or hexagons (*ibid.*, p.25).

Natural geographic irregularities may deform or even suppress the hexagonal space filling net, but it is striking to see that **dissipative structures** observed by BENARD and related to **energy** dissipation in **emergent systems** tend also to take hexagonal forms.

This is perfectly consistent with both classical and Prigoginian **thermodynamics**. As noted by C. JOSLYN, hexagonal packing "... can be shown to maximize ... **energy flow** and **thermodynamic entropy production**" (1991, p.641).

Either we witness a **dynamic equilibrium**, with stable hexagonal space filling (sustained by a **stable energy flow**), or observe the progressive **emergence** of a new **structure** as a result of the "flooding" of the system by massive and sustained **energy** supplements, which lead the system to a higher **level of organization**, i.e. of **entropy production**.

→ **Density of occupancy; Foraging theory; Isotropy; Substrate**

1532

HIERARCHIC LEVEL²⁾

A specified level in a vertical or tree-like **structure** or **organization**.

Any complex system is hierarchically organized, in correspondance with the **regulations** and **controls** of its various **functions**, which need to be coordinated and harmonized in order to secure the **survival** of the system.

Hierarchic levels would seem to have historically appeared first in **living systems**, but even possibly in prebiotic ones.

1533

HIERARCHIC MODELS VS. PARALLEL ONES²⁾

Since long time, and still on-going, there is a controversy between the proponents of hierarchic or parallel models or **organization**, in general.

A specific case, i.e. "**Cognitive systems architectures**" has been considered by Marta OLIVETTI BELARDINELLI (1998, p. 11-26). She advocates for an "**integration** of perspectives". Historically the hierarchic view has been dominant, at least in western thinking. This was probably a result of the search for short-cuts in the **management** of complex situations of all kinds, as the hierarchic ordering leads easily to unconscious or conscious **algorithms** of treatment ("Act according to the **rules** and so, avoid problems")

It should however be observed that:

1- Any hierarchical **order** has been constructed in a historical **dimension**

2- The hierarchical view, when strongly established, tends frequently to block needed **adaptation**

In turn the parallel way implies the possibility of unlimited **adaptability**. In OLIVETTI BELARDINELLI's words: "There maybe some justification for claiming the superiority of hierarchical structuring, which relies on **input-specific** systems with differentiated processing, interconnected according to a **structure** compatible with the classical architecture of the **nervous system**. However, the limitations imposed by this type of structure on the explanation of **adaptation processes** seem far more serious than those characteristic of **connectionism**, that is, regarding the **optimization** of **processes** as **complexity** increases"(p. 17)

In short, hierarchic structures and **models** could represent the more or less **periodic** summing-up of the stabilized results of adaptation processes through parallel **activity**.

→ **Bottom up; Parallel distributed processing; Top down**

1534

HIERARCHIC ORGANIZATION OF THE SYSTEM²⁾ - 4)

"The type of ordering in which individual **elements** of the system are systems of lower **order**, and/or the system under study appears as an **element** of a higher-order system" (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.55).

According to these authors: "Any given system can be adequately described provided it is regarded as an **element** of a larger system... The problem of presenting a given system as an **element** of a larger system can only be solved if this system is described as a system" (p.270).

The authors refer to this as the "paradox of hierarchy" and state that it "essentially represents a statement of **interdependence** of the solution of two problems: 1) the **description** of the system as such, and 2) the **description** of the system as an **element** of a larger system" (p.271).

This looks like a practical application of **GÖDEL's incompleteness theorem!**

These notions are however somewhat ambiguous and questionable, when applied to real **situations**. For example, many consider that the member countries of the European Community are the **subsystems**, while the real future functional **subsystems** of the E.C. (i.e. its supra-national institutions) are still a-building, a **process** in many cases obstructed by some national negotiators or pressure **groups**, generally representative of the national **subsystems** whose power would suffer limitations from the new community **subsystems** (see "**Hierarchic emergence**").

From a more formal viewpoint, as stated by G. KLIR "Hierarchical organizations are important not only for reducing descriptive **complexity** of systems, but they play also a significant role in reducing computational **complexity** of some systems problems... If the partitioning of hypotheses can be arranged hierarchically on several **levels**, the reduction of computational **complexity** may be phenomenal" (1993, p.49).

1535

HIERARCHIC STRUCTURE

→ **Structure (Hierarchic)**

1536

HIERARCHIC SYSTEM ^{1) - 2)}

"A system composed of **subsystems** that, in turn, have their own **subsystems**, and so on" (H. SIMON, 1958, p.64).

H. SIMON states: "By a hierarchic system, or hierarchy, I mean a system that is composed of interrelated **subsystems**, each of the latter being in turn hierarchic in **structure** until we reach some lowest **level** of elementary **subsystems**. In most systems in nature, it is somewhat arbitrary as to where we leave off, the partitioning and what **subsystems** we take as elementary" (Ibid).

SIMON notes how the physical **concept** of "elementary particle" has evolved within the two last generations. Other examples, biological or astronomical, show that an "elementary **subsystem**" is largely a matter of definition by the **modeller**.

He also stresses that the relations among **subsystems** are quite more complex than an univocal and common **dependence** from an upper **level** or rigid **control** over inferior **levels**.

Hierarchic systems are indeed made of co-regulated **subsystems** and a **meta-level's** role is (or should be) more of **regulation** and **cohesion** than of domination.

→ **HORA and TEMPUS parable**

1537

HIERARCHIES (Connexions between various types of) ^{1) - 2)}

B. WALLISER classifies hierarchies within four types (see infra: "**Hierarchies (Typology of)**")

According to him these "four types of hierarchies may be distinguished from each other in different ways:

- qualitative and **structural** hierarchies, are based on an **embedment** principle by which the higher **level objects** are the inferior **level sets**, while **functional** and genetic hierarchies are sequential, based on an influence principle, where the **objects** of the superior **level** are of the same nature as those of the inferior **level**;
- qualitative hierarchies include **objects** on a similarity base, which do not necessarily have direct relations (material or logical) amongst them, while the other hierarchies include **objects** which generally are strongly interactive because of their proximity or sequentiality;
- genetical hierarchies are explicitly related to a **diachronic** viewpoint and exist only because of this temporality, while the other hierarchies correspond to a **synchronic** vision and remain invariable during a given **period**, even in case dynamic **phenomena** take place within them" (1991, p.74).

He adds: "Some hierarchies may be superposed in the sense that, with a similar arborescent **structure** among **objects**, the relations may be understood in two different ways. Thus, the qualitative hierarchies coincide with the other ones if the **classification criteria** of the **objects** are precisely their membership of the same **set**, their functional **complementarity** or their common origin (for example: phylogenetic **classification** of animals). Likewise, **structural** and **functional** hierarchies merge when an integrated **subset** is "represented" by one of the **elements** which assume a leadership (as in an enterprise organizational chart). Finally, **functional** and genetical hierarchies fuse if the **objects** submitted to some other of superior **level** have been generated by it (parental authority in a family).

"Some hierarchies are also **embedded**, if the **objects** in some type of hierarchy are already hierarchies pertaining to some other type. It is thus possible to have a qualitative hierarchy which uses as **classification rule** for the **objects** the similarity of their hierarchical **structure**, of their hierarchical **regulation** (centralized or decentralized **organization**) or their hierarchical generation. It is likewise possible to find some **functional** hierarchy composed of

objects made of a **structural** hierarchy (f. ex. **regulations** in an oil refinery made of men and machines). Finally it is possible to observe some genetical hierarchy in which each generated **object** is in turn a **structural** or **functional** hierarchy (ontogenesis **process**)" (p.74).

1538

HIERARCHIES (Properties of) ²⁾

According to B. WALLISER: "The properties of hierarchies may be studied from three viewpoints:

"- their **organization** is arborescent, the **nodes** being formed from **homogeneous** or **heterogeneous objects** and the characteristic relations connect every **object**, in principle in an exclusive way, to some immediately superior **object**. Moreover the **tree** is generally characterized by its depth (number of **levels**) and its extension (average number of descendants per **object**);

"- their workings result of the **complementary** or alternative **behavior** of the different entities, and of the concrete **interactions** between **levels** (**interactions** of various types and **frequencies**). The global **structure** is sometimes related to some **environment**, itself hierarchical, with **communication** at each **level**;

"- their **evolution** includes the initial upbuilding which quite naturally takes place by successive **levels**, but also includes either the ulterior rebuilding related to the modular modification or replacement of the **elements**, or a **re-structuration** or reordering of the **network** of their **relations**" (1991, p.75).

1539

HIERARCHIES (TEMPORAL) ¹⁾²⁾

The general ordering of natural **phenomena** (but also probably of the social ones) seem to result of **trade-offs** between **rhythms** of different **periodicities**. B.T. WERNER writes: "Fast **variables** become slaved to low variables and lose their status as independent dynamical variables" (1999, p. 103)

This corresponds to **power laws** and to HAKEN's **slaving principle**.

1540

HIERARCHIES (Temporally embedded) ²⁾

B. WALLISER emphasizes the temporal aspect of hierarchies in evolving **situations**: "...the "temporally **embedded** hierarchies" offer **short, medium and long term phenomena**, defined by corresponding different velocities of variations: the slow **variable** "frames" the quick ones and these become "integrated" into the slow one" (1991, p. 75).

This is very significant, because it implies an integrated theory of **cycles**. See: "**KONDRA-TIEV cycle**".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1541

HIERARCHIES (Typology of)^{1) - 2)}

B. WALLISER establishes in the following way a typology of hierarchies:

"- **Qualitative hierarchies** in which various **objects** are classified according to the similarity of their properties in some **homogeneous** subcategory, various of which become in turn grouped in a larger **category**. This leads from a particular **level** to a more general one through various steps, by way of a subdivision **link**.

"- **Structural hierarchies** in which various **objects** are collected according to their spatial proximity in some **homogeneous subset**, various of which become in turn integrated into a wider **set**. This leads from some micro-level to a macrolevel through various **strata**, by way of a subagency **link**.

"- **Functional hierarchies** in which various entities are submitted to the deciding authority of a superior **regulating** entity, various of which are themselves coordinated by a higher entity. This leads from an infra **level** to a supra **level** through various "**echelons**" by way of a subordination **link**.

"- **Genetic hierarchies** in which various entities come from an original common entity by temporal filiation, various of these latter themselves coming from an older one. This leads from a former to a later **level** through successive generations by way of a sequential **link** (1991, p.72-3).

WALLISER shows in his paper how these four basic types of hierarchies show up in the most varied systems and gives numerous examples.

1542

HIERARCHY^{1) - 2)}

An asymmetric vertical **order** in a system through which **elements** or **subsystems** of a lower **level** of **complexity** are regulated or controlled by one or several others of successively higher **level**.

The hierarchy **model** itself, as an **isomorphism**, generally pervades any specific hierarchized system, i.e. the **subsystems** themselves, down from **level** to **level**, are true to the hierarchical type.

M.D. MESAROVIC, D. MACKO and Y. TAKAHARA developed a general "Theory of Hierarchical, Multilevel Systems" (1970) in which they study the concept of hierarchy, the basic types of hierarchies, the **levels** of **complexity** and establish a mathematical theory of **coordination** in unconstrained or **constrained** systems. As stated by these authors: "The requirements for proper functioning of a system on any **stratum** appear as conditions of **constraints** on the **operation** on the lower **strata**" and "... for a proper functioning of the system on a given **stratum**, all the lower **strata** have to function correctly" (p.41).

According to J.C. LUGAN a **cybernetic** hierarchy of systems can be established wherein **information** rich systems tend to control **energy** rich ones (1993, p.46).

According to J.A. GOGUEN and F.J. VARELA: "The idea of hierarchy is often presented from the point of view of the **interdependence** of different **levels** of systems **descriptions**. Particular instances of hierarchical **structures** including **multilevel cooperation** can be found. GOGUEN presents a general theory of hierarchical systems of interdependent **processes**. Its basic ideas are **interconnection**, **behavior** and **level**, and its theoretical framework is categorical algebra" (1979, p.35).

The most obvious **function** of hierarchies is the **coordination** one, which is quite visible in **living systems**. However, in human **organizations** this **role** can be obscured when **coordination** is managed by ill-informed and authoritarian **controllers**. Another important **function** for the higher **strata** in hierarchies is **adaptation** and **creativity** in case of important **changes** in the **environment**.

From the basic viewpoint of the nature of hierarchy, and according to D. BOHM and F.D. PEAT it is a result of "... the **activity** of the generative principle within the **generative order**" (1987, p.164).

According to this view, hierarchy results of the progressive **morphogenesis** of **complexity**. Remains to be seen how this **generative order**, which seems to be at work in all **complex systems**, organizes **morphogenesis**.

A **complex system** generally shows various hierarchic **levels**, the lower ones being **embedded** into the higher ones. A. KOESTLER emphasized the "double-faced" aspect of **elements** in a hierarchy: they function as **wholes** in relation to lower **levels** and as **elements** of **wholes** at a higher **level**.

A good example of hierarchy is found in any complex **living system**, as shown by J. G. MILLER (1978).

The **concept** of hierarchy implies **asymmetric dependence** relations. It is in this sense that, as stated by D. WILSON, the taxonomic Linnean hierarchy is "... a system of **nested classes** whose members are individual **organisms**" (1969, p.4).

1543

HIERARCHY AS A NETWORK²⁾

B. WALLISER in no way opposes the **concepts** of hierarchy and network and he connects them in the following way:

"The notion of hierarchy evokes the image of an arborescent **structure** where various **objects** do have "vertical" relations, oriented toward an **object** on a superior **level**, various of these superior **objects** being in turn oriented toward another one, at a still superior **level**. It seems opposed to the image of a reticular **structure**, wherein **objects** have "horizontal"

relations, sometimes very intricate, where **loops** do appear in such a way that no precedences seem to exist. However, even in a hierarchy, **objects** which are connected to another one of superior **level**, may have direct relations with each other. The nature and intensity of these relations may even contribute to the definition of the successive **levels**" (1991, p.71).

St. BEER exemplifies such networks (which he calls "hierarchical stochastic networks", showing that they are more satisfactory **representations** of complex **organizations** that the classical "tree", because they show that hierarchic **levels** can be somewhat **fuzzy** and allow for some leeway in personal or institutional **relationships** (1968, p.194, fig.16).

1544

HIERARCHY (Classificational)²⁾

"A **function** which assigns to each **object** the appropriate **label**... from a **set** of **labels** (R.C. CONANT, 1974, p.9)

CONANT writes that each **label**: "...depends upon and carries **information** about the constellation of characteristics" and adds that: "To select the proper **label** the classificational hierarchy must be provided with $\log_2 N$ **bits** of **information**, on the average, about the characteristics of the **objects** (less if the **labels** are not equally probable)" (Ibid.).

1545

HIERARCHY (Distributive)²⁾⁴⁾⁵⁾

A multi-centered type of hierarchy that admits regional **dominance** around local centers.

This **model** comes from geography. It has been used for ex. for the study of AIDS propagation. If some **phenomenon** should diffuse from a unique center, such a **process** would be very slow. However a pathogen can easily "jump" from one point to another, sometimes very distant, and become there the focus of a new **diffusion** center.

The **model** is quite general and can be applied to the diffusion of a new **technology**, or of a new religious creed, or a forest fire, or a financial panic.

It is closely related to the **concepts** of **composite system** and **percolation**.

1546

HIERARCHY (Emergent)^{1) - 2) - 4)}

The **emergence** of a system of a superior **level** of **complexity** goes with a deep reshaping of the internal as well as reciprocal **organization** of the newly associating **components**. The following aspects are specially noteworthy:

1) the **components** lose a part of their **autonomy** when they enter in reciprocally conditioning **interrelations**;

2) their **control** over their own **elements** is somewhat reduced, specially when these **elements** start to participate as such in macro-interactions;

3) the new emerging **interrelations** require a **coordination** at their own **level**, which implies the shaping of a superior hierarchical **level**;

4) the **functions** of the **components** do not become the **functions** of the **emergent** system, which may need, demand or provoke their weakening or even their elimination;

5) certain constitutive **elements** of the **components** may escape from their **control** and integrate themselves directly to the **emergent functions** of the new system;

This type of **situations** is more common than generally believed.

The moulting **processes** that lead to the adult insect seem to be true to this **model**. It is also probably the case of embryonic reorganizations during the pregnancy and quite certainly of the present **emergence** of the supranational systems.

1547

HIERARCHY (General)²⁾

Prof. M. KALAJDIEVA (Institute of Control and Systems Research of Sofia, Bulgaria) proposed the following postulates for a general concept of hierarchy. she writes:

POSTULATES OF GENERAL HIERARCHIE

1. A general hierarchie GH is an *one-dimensionally orientated multi-dimensional structure* of constructs (structures), up to infinite-dimensional.

2. Each general hierarchie is represented by two coupled GHs – one GH with an *inverse general hierarchie* having exactly the same structure, but defined with the opposite orientation of its direction.

3. *Deadlocks* are tolerable within a GH, only if they can be represented as cycles *interruptible* at a defined place under defined conditions.

4. A theoretical contextual difference is made between *elements* and *nodes* of a hierarchie. Many methods of modeling GHs rely on this separation.

5. The nodes of a GH may have both multiple outgoing and in-going connections. This particular feature is *polyhierarchie*. A general hierarchie having the feature of polyhierarchie is called *polyhierarchie* GH or shortly – *polyhierarchie*.

6. A general hierarchie *need not be connected* in all its parts. The mutual belonging of several parts possess individual identic or similar contextual characteristics, stating that number of (dis)connected structures are (parts of) one and the same general hierarchie.

7. The contextual characteristic is called *invariant characteristic (IC)*. The contextual ICs are described (defined) in *natural language*; their variety is *unrestricted*. There are nine

primary ICs: *direction, aspect of decomposition, element, node, connection, (algorithm of, rules of) decomposition, polihierarchie, polythematics, measure*. They might be independent of one another or not depending on the context of GH design and analysis. Four secondary ICs are derived from the system of the primary nine *composition, inverse hierarchie, level and step*.

8. General hierarchie(ies) may be modified (re-arranged) by

a) *Operations* which build by construction set up an *algebra* in the special mathematical sense of this term. They are *addition, subtraction multiplication and division*. Basic elements of the algebra are of two kinds of bases:

- 1st order base of algebra containing constructs of 2 nodes bound with 1 connection (or 2 connections bound with 1 node);

- 2nd order base of the algebra containing constructs of 1 nodes, all its subnodes and bound with as many connections.

b) Altering the *values or meanings* of invariant characteristic(s). Such changes may also change the degree of abstractness of modeling complex objects in GH(s) or change the context of modelled constructs, e.g. for comparative study.

c) *Special operations* typical only for the set of general hierarchies and bound to the context of the GH(s): *normalize* GH(s) on one and the same level, *haul up* and *haul down* across level (steps).

1548

HIERARCHY (Law of Requisite)^{1) – 2)}

"The lack of regulatory capability of a single **regulator** can be compensated for, to some degree, by conceptualizing the **regulator** as a hierarchical **multilevel structure** system".

This law, thus formulated by G. KLIR (1991, p.183) is due to A. AULIN (1989). KLIR comments: "In general, the weaker the regulatory abilities of available **regulators**, the more hierarchy is needed to achieve the same regulatory **performance**, if it is possible at all" (Ibid).

AULIN's law should be pondered not only for *engineered regulators*, but also for natural ones. (See Ch. FRANÇOIS, 1983, on "**controls**"). We urgently need discovering the higher **level regulators** in **ecosystems** and **socio-systems**.

1549

HIERARCHY (Organic)²⁾

According to R.C. CONANT, this class of hierarchies: "... is meant to include all hierarchical **"organisms"**, in a broad sense, which have a dynamic, physical existence and for which the **concept of survival** (in the face of threats from the **environment**) is relevant"...

But "... 'conceptual' hierarchies such as **language** and music are not included" (1974, p.11).

1550

HIERARCHY Theory²⁾

At the 1998 Conference of ISSS in Atlanta, J.M. WILBY described as follows the state of the art in hierarchy theory: "(it) is one of several possible **systems approaches**...used in the study of **complexity**...in the observing of complex **situations**. The theory is systemic in itself, dealing with the **issues** central to systems science, e.g. the importance of the **observer**, and the **flows** of **matter, energy, and information** through systems".

Hierarchy theory has been applied in such diverse **fields** of study as ecology, biology, linguistics, business, philosophy, mathematics and physics" (1998 Abstracts, p. 190)

"...an ongoing research...aims to determine the utility and validity of hierarchy as a systems approach for: 1) the analysis of existing **complex systems** and problem situations; 2) the **planning** of interventions in existing complex situations, and 3) the **design** of future systems

"Outcomes of the overall research will include the construction of a set of principles for hierarchy theory, the evaluation and design for a **methodology** for hierarchy theory, and the critical **evaluation** of hierarchy theory..." (Ibid)

This research is going on at the Lincoln School of Management at the University of Lincolnshire and Humberside, U.K.

1551

HIPPOCAMPUS¹⁾⁵⁾

One of two ridges along each lateral ventricle of the **brain**.

Hippocampus is a part of the limbic system, which is the seat of emotions and manages them. It is essential for the creation of **long-term memory** through the establishment of so-called **mental maps**. It has been observed that the taxi-drivers in a great city have a particular development of the hippocampus. On the contrary, damage to the hippocampus leads to considerable spatial desorientation. It also impairs the acquisition of **short-term memory**.

It seems moreover that the passage from short-term to long-term memory is obtained by "replays" by the hippocampus (also during sleep) that finally "etch" the lived experiences deeper into the cortex (Rita CARTER, 1998)

The hippocampus is the bio-physiological **structure** basically responsible for the implicit memory, called "retention" by HUSSERL, that allows us to understand as integrated **whole** a sonata, for instance, or any other phenomenon extended in **time**.

→ **Brain (Triune)**

1552

HISTORICAL DETERMINISM^{1) - 3)}

The global influence of former **states** of a system on its present and future **states**.

This is not Marxian historical determinism.

Neither is it the rigorous **monocausal determinism** of classical mechanics, nor **statistical determinism**. It corresponds to BOLTZMANN's after-effects ("Nachwirkungen"), i.e. the **effects** of the accumulated and registered or recorded **events** in the past of the system.

However, in **complex systems** this kind of "memory" does not lead to strict determinism, but merely to **sensibility to initial conditions**. This in turn endows the system either with **ergodic behavior**, or with **chaotic** characteristics.

D. RUELLE writes: "I think that history systematically generates **events** that cannot be predicted and have important **long-term** consequences" (1981).

V. VOLTERRA, starting from BOLTZMANN's equations, showed that they implied "the **initial conditions** of the system, under the form of an integral (or more generally a function) which represented the whole **information** related to the past of the system, unlike the classical vectorial form that represented only the present **state**. In this way, the system was not anymore deterministic in a strict Laplacian sense: its present is not anymore sufficient to determine its **evolution**; which is determined by its past as a whole" (G. ISRAEL, 1992, p.268).

We thus have a historical systemic determinism, with precise and specific characteristics.

J. HOLLAND in turn, observes that: "... future **populations** can only develop via **reproduction** of individuals of the current population. In particular, the population must serve as a summary of observed sample values (**performances**)" (1992, p.13).

Of course, "populations" can be of very different types: biological individuals, genes, techniques, **bits of information**, **memes**, etc...

Thus, while **innovations** open new possible futures, they are possible only on the base of the "presently remembered" (or registered) past.

→ **Present (Everlasting); Time binding; Time perception**

1553

HISTORICAL DIMENSION in systems¹⁾

Any **nonlinear irreversible system** has its own history. This is a consequence, in I. PRIGOGINE words of: "...**symmetry breaking dissipative structures** in which the system has the "choice" between various possibilities. The type of initial **fluctuations** determines the specific **dissipative structure** which will be realized. Once realized this **dissipative structure** is stable against the type of **fluctuations** considered. Successions of **instabilities** of this type

may occur, involving a kind of primitive **memory** or, so to say, a historical dimension. The present **structure** of the system can only be understood in terms of the succession of **instabilities** through which it was originated" (1973, p.71). Thus, wide **fluctuations** and the resulting **bifurcations**: "... introduce in a sense "history" in physics" (1978, p.46).

This is also explained in the following way by G. NICOLIS; "A **bifurcation** is really a moment when a **decision** is taken as... the system is confronted with multiple **choices**. It thus becomes sensible to **random effects** that, by way of statistical **fluctuations**, will finally favour one of the accessible **states**. Once channelled on one specific branch of **states**, the system will follow a course closely determined by this **critical choice**. In some sense, it then becomes a *historical object*, which will forever keep the record of former **events** that prevailed at the successive **bifurcation** points encountered. In sum, in addition to **deterministic elements**, **concepts** like **randomness** and history play a primordial role in **evolution**" (1984, p.12).

NICOLIS calls this "the insertion of **time** within **matter**" (Ibid).

1554

HISTORICITY¹⁾

A basic characteristic of any system as evolving in **time**.

Historicity is now firmly established as a systemic **process**. It has been confirmed by the Prigoginian **dissipative structuration model** as well as by the **deterministic chaos** one. The latter insists on the importance of a very precise - and quite difficult to obtain - good **knowledge** of the **initial conditions** and their ulterior evolutive **transformations**.

On the other hand, **sensibility to initial conditions**, as a basic characteristic of **deterministic chaos**, results in a new understanding of **irreversibility**, because it introduces the need for a better knowledge of the past of any system.

1555

HISTORIOGRAPHY: a critical view¹⁾²⁾⁴⁾⁵⁾

"The narration of a series of socially significant **events**". (A FUENMAYOR and R. FUENMAYOR, 1999, p. 69)

These authors - adscribed to **Interpretive Systemology** (University of Los Andes, Mérida, Venezuela) add "... significant according to certain more or less hidden **criteria**- among which a pseudo-causal thread is strung (the thread corresponds to the criteria which makes the events significant)".

They explain this disquieting comments as follows: "Historiography assumes that the **sequence of events** occurs on a culturally fixed stage. Thereby, historiography disregards that the events are what they are in terms of the cultural **context** that gives them **meaning**...

"The historical question is not simply: "Which events have led us to the present?" but, "What has been the series of cultural **contents** (which have made what has happened significant) that have led us to experience reality (including **history**) in the way we do at present?"

"Our history -ours, as a particular society- is not simply the history of the events in which our forefathers participated, but the history of how we come to appreciate **reality** and transform it (and both appreciation and **transformation**-are inseparable) in the manner we do today. It is the history of how we arrived at that cultural context that we now wish to impose on past events".

This is of course why history is rewritten by each generation and also written differently in different places.

However, in such **interpretive systemologic** terms, this sinks history into irremediable relativism. While this must certainly be taken into account, different insights in systemic terms seem possible, at a **meta-level** critique and also using **systemic models**, as for example **autopoietic social reproduction**, **dissipative structuration** and **emergence**, **dynamic stability** and the like.

As to the marxist view of **historical determinism**, it could probably be usefully reconsidered in the light of **thermodynamics** of **dissipative structuration**.

Two different- but closely interdependent- **processes** became active during the 19th and 20th centuries.

The first one was the ever more massive injection of **energy** (mainly fossil) in the **production process**. This trend became first active in England. Later on it propagated to Western Europe, and finally to the whole world (a process still running its full course presently)

The second one, i.e. technological **progress**, entered in a **positive feedback loop** with the first one. In fact, most of the present artificial devices are depending on the more or less massive use of energy. They were translated from laboratories to fields and factories only when they become efficiently amplified by a suitable energy **source**.

The whole process became mirrored in the **emergence** of a generalized societal structuration, unavoidably needed for practical use. Impressive examples are the material, informative, professional, bureaucratic and legal superstructures that made possible the massive use of the motorcar and the aircraft.

The global **sociosphere** in the making would have been impossible without the simultaneous (and even previous) development of the **technosphere**. The way this latter did build up- and specially the capitalistic (and later on the state-controlled) **concentration** of production tools was a more or less unavoidable consequence of the progressive construction of a close-knited technosphere.

→ **Historical determinism; Historical dimension in systems; History (Systemic); Saint Mathews principle**

1556

HISTORY DETERMINED ¹⁾

"Attribute of systems whose **behavior** is specified or can be understood better by looking into their past history" (K. KRIPPENDORFF, 1986, p.35).

According to KRIPPENDORFF: "In contrast to **state determined** systems, **predictability** of the future **states** of such systems improves when relying not only on their current **state**, but on a finite **sequence** of **states** preceeding it" (Ibid). He notes the relation to "higher-than-first-order **Markov chains**" and argues "that all history determined systems are incompletely observed **state determined** systems and that the recourse to history has **heuristic** value" (Ibid).

1557

HISTORY (Systemic) ^{1) - 3)}

L.von BERTALANFFY expressed his belief in the possibility of theoretical history: "Sociology is essentially concerned with a temporal cross-section as human societies are; history with the "longitudinal" study how societies become and develop... It seems history can learn from the system theorists, not ultimate solutions but a sounder methodological outlook... The construction of conceptual **models** in history is not only permissible but, as a matter of fact, is at the basis of any historical interpretation as distinguished from mere enumeration of **data**, i.e. chronicle or annals" (1962, p.15).

However, historic systems (i.e. human **groups** in general, states, cultures) are **nonlinear** in their **evolution**, and thus both globally **deterministic** and, at critical moments, probabilistic. Thus, merely **homeostatic models** would be insufficient and, in many cases, downright unsatisfying. S. GOONATILAKE, following P.M. ALLEN, sees history as a sequence of **bifurcations**. (1991, p.162).

Indeed, as stated by L. D. KIEL: "(In) human history... in many cases, the most significant **events** were those when existing **symmetries** dissolved and were replaced by new **patterns** of **interaction** and modes of **organization**" (1993, p.35).

The obvious and progressive acceleration of history (emphasized and thoroughly investigated by F. MEYER, 1954) seems to be related to the also progressive acceleration of the use of **energy**, which – after a slow **growth** since the paleolithic era – took an exponential **rhythm** since the 18th Century. It is thus a **thermodynamic process** of **dissipative structuration** in a **system far-from-equilibrium**, submitted to wild **fluctuations**.

This compiler believes that history needs a general **model** applicable to any human organized congeries and to their **transformations** through **time**. (Ch. FRANÇOIS, 1986 – See "**Socio-historical system**").

From another viewpoint, systemic history could become a useful tool for **sociognosis**, i.e. a better self-understanding of societies- a kind of collective consensual and Socratic "gnôti seauton", analogical to **autognosis**.

Some specific difficulties should however be considered. Each historian has his own **reference frame**, related to his cultural surroundings. IBN KHALDUN for ex., had necessarily as a 14th Century moslem historian, an approach and worldview very different from A. TOYNBEE or F. BRAUDEL in the 20th Century.

As a result, even if **methodology** could become definitively established, for example in systemic terms, every generation within every **culture** will easily want to revise past history in its own terms.

History tends to develop as a succession of evolving **interpretations**. This is a kind of extension of DILTHEY's "Entwicklungsgeschichte" ("developmental history"), as applied to philosophy (1922-1938), sections xvii-xviii)

Moreover, specific interpretations of history in a culture tend to become **autopoietic** in that culture.

1558

HOG CYCLE

A succession of more or less **periodic** gluts and shortages triggered by unrealistic **forecastings** based on spurious **extrapolations** (of the type "more of the same")

The expression alludes to the known fact that, if there are few hogs (or any other commodity) on the market, they will fetch a high price.

This will induce many farmers to breed hogs, which results in a future glut of hogs and, inevitably, in a crash of their sales value.

"Extrapolating from the present, (farmers) get the future wrong" (Economist 23.03.96, p.13)

The hog cycle is a good example of a **forecasting** trap.

Extrapolation from a **short term trend** is practically always wrong, because there are longer **trends** that supersede the shorter one. However, as this can also be true of the longer **trends** themselves, even the anticyclic view does not offer a very high degree of **probability**, and still less any certainty.

1559

HOLARCHY ¹⁾⁴⁾

"A **behavior** that is partly a **function** of individual nature and partly a function of the nature of the **embedding system**" (K. BAUSCH- Glossary- Pers.comm., 2002)

A hierarchized (i.e. **multi-level**) system with a number of **components** at each level, connected with components of the upper and lower levels.

The term was introduced by KOESTLER (1969, 1978)

Holarchies are characterized by the **embedding** (or embedment) of groups of elements at a superior level, where they are considered as individual **elements**, or **subsystems** in relation to a still higher embracing **level**. They can be representd as inverted trees, generally with a **fractal** architecture.

The holarchic **model** applies to biological and **social systems**, but not to **congeries**, nor in general to **colonial systems**, to composite systems affected by critical episodes, or to **ecosystems**.

A Csanyi's **zero-system** may become holarchical when stabilized.

In a recent paper, F. PICHLER elaborated on the holarchical model corresponding to "self-regulating open **hierarchic order**"(SOHO), using it in relation to **multi-agents systems**, that can be considered on their way to become holarchic. (2000, p. 80-84)

The **concept** seems to be more meaningful for **groups** and societies than for individuals. Any human group must adapt to specific environmental conditions and consequently develops a behavior adequate at the same time to its necessities and to the **constraints** of its **environment**.

This is why some authors have written about "islands cultures", "cultures of rice", "desert cultures", etc.

In such cases any individual behavior remains circumscribed within the general behavioral **rules** of the **whole** group.

The concept could also possibly be used for more specific groups: each enterprise, or administrative service, or even sport or entertainment groups seem to develop this type of behavior.

→ **Holon**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1560

HOLISM^{1) - 3)}

"A descriptive and investigative **strategy** which seeks to find the smallest number of explanatory principles by paying careful attention to the **emergent** properties of the **whole**, as opposed to the **behavior** of the isolated **parts**, as chosen by the **observer** in a **reductionist** strategy" (T.F.H. ALLEN & T.B. STARR, 1982, p.270).

The term and the **concept** were introduced in 1926 by the South African general and statesman Jan SMUTS. The term was derived from the Greek: "holos" = **whole**.

SMUTS wrote: "The idea of **wholes** and **wholeness** should... not be confined to the biological domain: it covers both inorganic substances and the highest manifestations of the human spirit. Taking a plant or an animal as a type of a **whole**, we notice the fundamental holistic character as a unity of **parts** which is so close and intense as to be more than the sum of its **parts**; which not only gives a particular conformation or **structure** to the **parts**, but so relates and determines them in their synthesis that their **functions** are altered; the synthesis affects and determines the **parts**, so that they **function** towards the **whole**; and the **whole** and the **parts** therefore reciprocally influence and determine each other, and appear to merge more or less their individual characters: the **whole** is in the **parts** and the **parts** are in the **whole**, and this synthesis of **whole** and **parts** is reflected in the holistic character of the **functions** of the **parts** as well as of the **whole**" (1926-1973, p.86).

M. BUNGE describes as follows the characteristic theses of holism, "the **ontological** view that stresses the integrity of systems at the expense of their **components** and the mutual **actions** among them":

"1. The **whole** precedes its **parts**.

"2. The **whole** acts on its **parts**.

"3. The **whole** is more than the sum of its **parts**.

"4. **Wholes** emerge under the **action** of **agents** that transcend both the **actions** among the **components** and the **environmental** influences.

"5. Totalities cannot be explained by analysis: they are irrational.

"6. The **whole** is better than any of its **parts**" (1979, p.39-40).

BUNGE sharply criticizes these thesis, reproduced however by him in a somewhat caricatural form (see hereafter)

According to ALLEN and STARR, both holism and **reductionism** seek to explain **emergent behavior** by invoking a lower **level** of **organization** (p.270).

Thus, both **strategies** admit the existence of **hierarchies** in systems.

J.A. GOGUEN and F.J. VARELA however observe: "Most discussions place holism/**reductionism** in polar opposition. This seems to stem from the historical split between empirical sciences viewed as mainly **reductionist** or analytic, and the (European) schools of philosophy and social sciences that grope toward a **dynamics** of totalities" (1979, p.40).

However: "It seems that both these directions of analysis always coexist, either implicitly or explicitly, because these descriptive **levels** are mutually interdependent for the **observer**. We cannot conceive of **components** if there is no system from which they are abstracted, and there cannot be a **whole** unless there are constitutive **elements**" (p.41).

These authors give the excellent example of harmony and melody, which are at "... a **level** of **organization** above that of the notes themselves" (ibid).

Finally: "**Reductionism** implies attention to a lower **level**, while holism implies attention to a higher **level**. These are intertwined in any satisfactory **description**; and each entails some loss relative to our cognitive preferences, as well as some gain" (p.42).

M. BUNGE holds a dim view on holism, which he carefully distinguishes from **systemics**, as holism "recognizes the existence of systems with specific characters (**emergent** properties), but treats them as totalities or **black boxes**". According to him holism "... refuses to analyse them and to explain the formation and the **collapse** of **wholes** in function of their **components** and the **interactions** between them" (1995, p.16). He also indicts holism as "responsible for the backwardness of the non-physical sciences. It has contributed precious little to serious systemics, precisely because: (a) it has not engaged in the study of the links that hold any system together, and (b) rather than constructing conceptual systems (theories) to account for **concrete systems**, it has spent itself in attacking analytical or atomistic approach and praising totality as such. Whatever **truth** there is in holism - namely that there are totalities, that they have properties of their own, and they should be treated as **wholes** - is contained in systemism, or the philosophy underpinning systemics" (p.410).

The most equilibrated view has been offered by G. KLIR who considers that present systems thinking: "... represents a synthesis of the **reductionistic** thesis and the holistic antithesis" (1993, p.36).

The French philosopher B. PASCAL anticipated (1670!) this view: "I consider impossible to obtain **knowledge** of the **parts** without knowing the **whole**, nor to know the **whole** without particular **knowledge** of the **parts**" (Quoted by R. VALLÉE, 1995, p.11).

The concept of **Gestalt**, as referring to the **perception** of **wholes**, also is another conspicuous root of holism.

Some view holism itself as a kind of **reductionism**. K. BAUSCH for ex. defines it as "A reductionist descriptive and investigative strategy for generating explanatory principles of **whole** systems" (Glossary, Pers.comm., 2002)

Indeed: "Attention is focused on the **emergent** properties of the whole rather than on the **behavior** of the isolates **parts**" (ibid).

Of course, holistic models should be paired with classical reductionist ones as both aspects are complementary and necessary for comprehensive **explanations**.

As a very simple illustration, while H₂O has specific properties as a whole, its constitution can be understood only by knowing the chemical and physical characteristics of H and O that allow them to combine.

1561

HOLISM (Law of Requisite)¹⁾²⁾

M. MULEJ and S. KAJZER introduced the Law of Requisite Holism in 1998 (see T. ECIMOVIC et al., 2002)

The Law "demands the author/s of the definition of a system representing the **object** under their consideration and/or **control** to clearly state what part of **attributes** of the object is included into his/her/their system, being the mental picture of the object under consideration and/or control" (2002, sect. 4.1)

The authors add: "He/she/they must do his/her/their best to fight oversimplification as well as too much **complexity** and complication, by using all available **knowledge** and **skills** as well as by **ethics** of **interdependence**" (ibid)

This means that the holistic **model** must not leave anything significant outside, nor overburden the model with irrelevant **elements**.

Of course, the crux of the matter are the **criteria** to be used to focus the holistic model in this way. Moreover, a very serious problem is that the **modeller** may easily be unaware of the insufficiency of his/her knowledge or may hold a prejudiced view. The authors explains possible ways to produce a holistic model that be satisfactorily focused, covering the **issue** as a **whole** and including all significant **relationships**.

Other authors, as for example J. WARFIELD and R. CARDENAS, or H. LINSTONE and I. MITROFF, and J. GHARAJEDAGHI have contributed interesting **methodologies** that should be used to construct models in accordance with the Law of Requisite Holism.

→ **Generic design; Unbounded Systems Thinking; Underconceptualization**

1562

HOLISTIC APPROACH^{1) - 3)}

"The view that an integrated **whole** has reality independent of and greater than its **parts**" (UNESCO, 1986, p.5).

"Independent" should be replaced by "distinct" in order to take BUNGE's objection into account.

The UNESCO – UNEP "Glossary of environmental education terms" comments that: "... the **environment** can only be understood by viewing it as a general complex of its **parts**" and that this can be done by way of a "thorough and comprehensive analysis of **interrelations** between the natural **environment**, social, cultural, technological and other factors" (p.5).

This applies obviously to any kind of **environment**, and must be extended to the system considered *and* its **interactions** with its specific **environment**. But it is in no way contradictory to more specific and precise research in some areas, provide both **viewpoints** become correlated.

1563

HOLOGRAM⁵⁾

A photography including diffraction **patterns** from which a three-dimensional image can be obtained.

Holograms are recorded by using lasers on photographic plates. "Holos" is the Greek equivalent for "**Whole**". As the Greek root "gram" means "write", then hologram, in D. BOHM words is thus "an instrument that "writes the **whole**" (1980, p.145).

Taking **dynamics** into account, BOHM describes the global **universe** as a "holomovement". This would give a kind of temporal dimension to some **objects** containing still traces of their past. Compare with "**aura**" and "**homeokinesis**".

Indeed, as stated by R. ROSEN: "In the hologram,... every point of the hologram contains **information** about *every* point of the **object**, so that the ripping a piece out of a hologram causes at worst a blurring or loss of **resolution**, but not the irretrievable loss of **information** pertaining to the **object**... For this reason, holograms are in fashion nowadays as **brain model paradigms**" (1974, p.173).

S. GOONATILAKE observes: "Using... holograms in three dimensions, enormous **interconnections** are possible. A cubic-centimetre hologram would allow for a trillion (10^{18}) **connections** alone, by interconnecting a million optical **elements**" Moreover: "Volume for volume the hologram therefore has an **interconnection** potential 100.000 times that of the **brain**. It appears that neural **connectionist** architecture using optical technology will not only increasingly dominate the future, but has the potential for reaching, if not surpassing, biological devices" (1991, p.110).

The holographic **analogy** is usefully applied to any system in which **parts** contain general **information** about the system as a **whole**. Possible examples are the **brain** and the administrative **organization**.

1564

HOLOGRAM (Non-local Quantum)¹⁾²⁾³⁾

This still very enigmatic concept- at least for this editor- has been discussed by E. MITCHELL (2000, p. 295-310) and a number of authors quoted in MITCHELL's bibliography (Ibid. p. 310-12), mainly since 1992.

Non-locality seems to imply a general sub-atomic cosmic **organization**, that could be a kind of **hologram**.

Self similarity could be distributed at the different **levels** of cosmic organization and manifest a global property (or global properties) also present at the quantum level and in our **brains** through quanta **processes**.

This would be the summing-up of basic **hologologies** between **levels**, as revealed by **WEIRSTRASS self-similar renormalization equation** and **fractals**.

This would imply a permanent **trade-off** in-between **bottom-up** and **top-down processes**, also at work in our ways of **perception**, **representations** and **understanding** of "**reality**", whatever this ambiguous term may mean.

MITCHELL writes: "Non-local **information** can now be seen as a ubiquitous and useful property of the cosmos rather than a unique **attribute** of particles (and human animals)"(2000, p. 298). This could possibly explain how we become able to construct **information spaces** (GERNERT, 2000, p. 255) more or less elaborated in accordance to our cerebral competence. It seems also to be compatible with MATURANA'S behavioral theory of **auto-poietic knowledge**.

The non-local hologram could also possibly bridge the temporal **dimension**.

All in all, the subject is fascinating and evokes many sidelines, but needs surely much more experimental work (in physics, and in **brain** research: for instance) and conceptual creation (without indulging in excessive **metaphorical** or empty **abstractions**)

Quantum holograms could also, according to MITCHELL, provide a scientific ground for parapsychology.

1565

HOLOGRAPHY as a metaphor³⁾

A way to represent a **whole** as a **network** of **connected** and more or less **redundant elements**, allowing simultaneously for specialization and a global **coherent behavior**.

The **brain** is now widely supposed to have an holographic **organization**.

A. HAUAN, J.A. JOHANNESSEN and J. OLAISEN characterize this **metaphor** as follows: "... the **whole** is enclosed in its **parts**: More specifically, if a holographic picture is broken into pieces, any single piece, when enlarged, will display all images of the original picture, al-

though maybe somewhat blurred. As a consequence, the "**whole**" could conceivably be reconstructed through a thorough analysis of any of the constituents **parts**" (1992, p.1057).

The **metaphor** implies that, within a system, any **element** should have (and in biological and cultural system, *have* indeed, as genes, **memes**, or **mindscapes**) at least a kind of historical imprint of the global **identity** of the system.

The holographic metaphor is as old as 19th Century's Arnold BÖCKLIN's "Public opinion" engraving that shows a gigantic dragon made of a multitude of similar dragonlets collectively **self-organized** in the suited way to ensure **self-similarity** between the micro- and the macro **level**.

1566

HOLOMOVEMENT²⁾³⁾

"A global and perpetual enfolding-unfolding dynamical dialogue where everything is connected to everything" (E. SCHWARZ's **explanation** of D. BOHM's **concept**)(1999, p. 140)

This somewhat ghostly global **model** of **reality** is tempered by the following comment: "In some instances, particularly at our normal **scale** of functioning (**mesoscale**), the holomovement may constitute relatively autonomous sub-**totalities** like the **objects** around us. In that case the usual way of considering separated objects interacting through external forces is a sufficient approximation (Ibid)

And "In the extreme case of non-**separability**, only the **whole** is true. There exist intermediate cases, like in particle physics experiments, where the **implicate order** can manifest itself by non-separable and non-local **effects**. For example, the particle-wave **duality** which appears as a paradox in the conventional interpretation of **quantum** mechanics, become limpid in the implicate-explicate model: the localized manifestations (quanta) belong to the **space-time** explicate order, whereas the wave-like effects are **reflections** of the **holistic** non-separable non-local implicate order. The wave or particle problem becomes the wave and particle double sided reality"

"Several other dilemmas, like **continuity/discontinuity**, **causality/non-causality**, **order/disorder**, **being/becoming**, **observer/observed**, mind/body, can be made intelligible with the double order model"(Ibid, p. 141)

Remains to find the **epistemologic** value of this model (What does it say about the ways of our **understanding**). And in the view of this editor, **ontological skepticism** is not eliminated by this mind-stretching **Weltanschauung**.

What would EINSTEIN have said? He, who did not believe in "spooky action at a distance"

→ **Reframing**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1567

HOLON ¹⁾ – 2) – 3)

"Any stable biological or social sub-whole which displays **rule**-governed **behaviour** and/or structural **Gestalt**-constancy" (A. KOESTLER, 1969, p.211).

KOESTLER gives the following explanations:

"1.1 The **organism** in its structural aspect is not an **aggregation** of elementary **parts**, and its functional aspects not a chain of elementary units of **behaviour**"

"1.2. The **organism** is to be regarded as a multi-levelled **hierarchy** of semi-**autonomous** sub-wholes, branching into sub-wholes of a lower **order** and so on. Sub-wholes on any **level** of the **hierarchy** are referred to as *holons*."

"1.3. **Parts** and **wholes** in an absolute sense do not exist in the domains of life. The *concept* of the **holon** is intended to reconcile the atomistic and holistic approach."

"1.4. Biological holons are **self-regulating open systems** which display both the **autonomous** properties of **wholes** and the dependent properties of **parts**. This **dichotomy** is present on every **level** of every type of **hierarchic organization**, and is referred to as the "Janus phenomenon".

"2.1 **Hierarchies** are "dissectible" into their constituent branches, on which the holons form the **nodes**; the branching lines represent the **channels of communication and control**."

"2.2 The number of **levels** which a **hierarchy** comprises is a measure of its "depth", and the number of holons on any given **level** is called its "**span**" (SIMON).

"3.1. Functional holons are governed by fixed **sets of rules** and display more or less flexible **strategies**."

"3.2. The **rules** – referred to as the system's *canon* – determine its **invariant** properties, its **structural configuration** and/or **functional patterns** (Ibid).

(For many more details, see reference)

The concept of "holon" has been sometimes misinterpreted, which led to unnecessary controversy. The holon is more than the sum of its **parts** because it includes the **interrelations** among these. But it is also less than this sum, because by entering in combination the **elements** lose some of their individual properties (or at least, they remain virtual and occult until the holon is destroyed). In order to make the point clearer, G. WEINBERG (1975, p.43) proposed the two following and somewhat paradoxically *complementary laws*:

"Composition Law:

The **whole** is more than the sum of its **parts**

"Decomposition Law:

The **part** is more than a fraction of the **whole**"

1568

HOLONOMY and HETERONOMY ¹⁾ – 3)

Holonomy is "the law of the **whole**". (→ "**Heteronomy**".)

D. BOHM writes: "Holonomy does not totally deny the relevance of **analysis**... Indeed, 'the law of the **whole**' will generally include the possibility of describing the 'loosening' of aspects from each other, so that they will be relatively **autonomous** in limited **contexts** (as well as the possibility of describing the **interactions** of those aspects in a system of **heteronomy**). However, any form of relative **autonomy** (and **heteronomy**) is ultimately limited by holonomy, so that in a broad enough **context** such forms are seen to be merely aspects, reelevated in the holomovement, rather than disjoint and separately existent things in **interaction**" (1980, p.156-7).

The perspective is finally neither **top-down**, nor **bottom-up**.

D. Mc NEIL insists that a **General Theory of Systems** should be holonomic, "i.e... contain a complete **representation** of itself, regardless of the **echelon** of **order** at which it is applied; for example, all of the central aspects of a **general theory of systems** must be represented in every subatomic system, mechanical system, social system, cosmological system, and every system in between. It must be **self-referential**, applicable to itself, and protean, able to change its own **form**" (1993, p.9).

While this author gives some interesting examples of such aspects, as for instance "**toroids**" and "**fluxes**", this remains still quite a tall order. One also wonders how this could be possible, in accordance with **GÖDEL'S incompleteness**.

The protean character however seems to exist, e.g. the various general formulation of the general theory: for instance SABELLI's **theory of processes**; HAKEN's **Synergetics**; PRIGOGINE's "total" **thermodynamics**; D. Mc NEIL's own's **dynamic systemology**; J.L.LE MOIGNE "**Système Général**" and others, less embracing.

1569

HOMEBOX ⁵⁾

A set of ordered and interacting **segmentation** genes which commands the also ordered **differentiation** and **development** of animals.

Such genes are called homoetic because each one is associated with some specific way of biological **structuration**, as for example producing a leg.

Homeoboxes are a very general feature of biological **organization**, from small invertebrates to insects and vertebrates, conveying a quite similar basic plan. They provide potential **positional information**.

Stephen DAY writes: "The amount of **positional information** builds up during the **development** of the **embryo**. Eventually the positional information is so complex that very small groups of **cells**, destined to become a particular part of the body, can be distinguished" (1999, p.4)

The homeobox is thus a basic "social **organizer**" proper to complex biological systems. A parallelism with **pheromones** in insect societies and **values** in human societies could be usefully researched.

Note: Some authors write "Homoeobox" in lieu of "homeobox" or "homeobox"

Homeoboxes, as specific ordered sequences of bases in developmental genes sequences, are now being closely studied (E. H. DAVIDSON & al, 1995).

It would be interesting to try to investigate the possible uses of this **model** to study psycho-sociological **constraints** in the **growth** and **stabilization** of all kind of societies, including the human ones.

→ **Regulation (Developmental)**

1570

HOMEBOX COMPLEX ⁵⁾

A distinctive DNA segment, consisting of some 60 amino acids, which is used by some group of genes to determine the basic body plan of a living **organism** (adapted from P. CORNING, 1988 b, p. 10).

The homeobox is a very archaic biological feature that has been conserved through the whole of **evolution**. It is present in the fruit fly (*Drosophila*) as well as in the human being.

According to CORNING it is "a microscopic example of a combination of labor that is oriented to the production of a combined emergent result" (See also De Robertis et al, 1990)

It is thus, from the systemic viewpoint, also an example of **emergence** of **complexity** through **synergy**.

The human genome research is of course closely related to the practical significance of the Homeobox Complex.

1571

HOMEOKINESIS ¹⁾ – 2) – 4)

The persistence of **coherence** among the **elements** of a system through its **transformations**.

D. Mc NEIL, who introduces the concept (pers. comm.), gives as an example the **transformations** of a hurricane whose "shape persists as a **stasis** amidst **flux**... despite continual transfusions, diffusions and exchanges of its substance, retaining its **identity**, regardless of whether its constituent molecules remain the same". Another example is a tree, or indeed any living being.

It seems to correspond to the **organizational closure** property in **autopoietic systems**.

Homeokinesis may also characterize the slow, but coherent historical **transformations** of natural **languages**, and even possibly of systems of **meanings**, **values** and **norms** in cultures.

1572

HOMEOMORPHISM²⁾

"The **transformation** between two geometrical figures A and B such that there is a continuous one-one correspondence *in both directions* between each point of A and a matching point of B" (T.A. & W. MILLINGTON, 1966, p.237).

This is the basic **topological transformation**, which is also very significant in **chaos theory**.

(Not to be confused with "Homomorphism" – see hereafter)

1573

HOMEORHESIS^{1) – 2)}

The condition of a **flow process** which remains canalised within **limits** in a growing system.

This neologism was created by C. WADDINGTON who explains: "Whereas the **process** of keeping something at a stable, or stationary **value** is called **homeostasis**, ensuring the continuation of a given type of **change** it is called **homeorhesis**" (1976, p.140).

In E. JANTSCH terms: "Homeorhesis ... (characterizes) the preservation, not of a **stationary state** (as in **homeostasis**), but of a **flow process**. **Disturbances** are counteracted so as to bring back the **process** not to where it was when disturbed, but to where it would have progressed if left undisturbed. Many biological and social **growth processes** are homeorhetic" (1975, p.92).

Growth of a system is normally homeorhetic, because it is the only way to maintain its identity. The system turns **homeostatic** (i.e. acquires **dynamic stability**) when it reaches its full **development**, in accordance with its **archetype**.

1574

HOMEOSTASIS^{1) – 2) – 4)}

The capacity of a system to maintain its **morphology**, its functionality and **internal states** at some definite **level** through **fluctuations** within established maxima and minima, in spite of changing external conditions.

Under the heading "**Constancy** of internal milieu", P. VENDRYES writes: "The coupling of **storage** and **control** has immense consequences for physiology, for through these mechanisms an **organism** maintains the **constancy** of its internal milieu. This happens despite incessant variations which can take place externally. This **maintenance of constancy** is a vital condition for **cells**, in which life **activities** take place. The intra-cellular milieu, while different from the internal milieus of the **organism**,

maintain continuous exchanges with them, and they also are kept constant. Claude BERNARD was the first to recognize this **constancy**, which was to be discussed later by CANNON (1932) in America under the term "Homeostasis" (1989, p.146)

Very numerous biophysical, biochemical and physiological examples of homeostasis have been discovered since BERNARD's, CANNON's and VENDRYES' work, as for example the **adjustment** of the pupil to the intensity of light, the **stabilization** of the cardiac **rhythm**, the **level** of glucose in the blood, etc...

Homeostasis can also be observed more generally in human systems (families, enterprises, **organizations**, nations, etc.) in which cases the term "**dynamic stability**" is more readily used. In some cases, as for instance, in G. BATESON's **double-bind**, homeostasis may become pathological.

Still, the homeostasis **concept** is somehow **mechanicist**: L.von BERTALANFFY wrote: "Although the homeostasis **model** transcends older **mechanistic models** by acknowledging directiveness in **self-regulating** circular **processes**, it still adheres to the **machine** theory of the **organism**" (1962, p.8).

Homeostasis can be maintained only within the **limits** of the **theorem of minimum entropy production** which, in PRIGOGINE words asserts that: "(in the **linear** region) a system evolves towards a **stationary state** characterized by the **minimum entropy production** compatible with the **constraints** determined by the **boundary** conditions" (1985, p.5). There is however a **nonlinear region** where a **bifurcation** takes place after ever widening **fluctuations**. In this **region**, the homeostasis **concept** is no more valid. This is generally a very important caveat, specially for social systems.

H. MATURANA and F. VARELA's concept of **organizational closure** is clearly related to homeostasis. It offers a model of an internal iterative **mechanism of maintenance** of the system's **identity** allowing for **circuits** of specific **states**. However, **organizational closure**, at its high **level of abstraction**, minimizes (or even in some authors, ignores completely) the challenging role of the **environment**.

Homeostasis is normally a result of a **set** of complex adaptive conditions, as for example arterial pressure, breathing **rhythm**, body temperature, etc..., among interacting **processes**, alternating according to necessities.

Of course, even a homeostatic system has a limited **tolerance** to **changes** in external conditions. Human systems are however able to enhance this **tolerance** by modifying their **environment**, at least up to a certain point.

Homeostasis is, at least, a property of biological, ecological and **social systems**, and probably of many physical systems.

W. KÖHLER writes: "W. CANNON ...prefers to give the name *homeostasis* to the fact that certain *steady states* are so obstinately preserved or re-established in the **organism**. **Equilibria**, he adds, are found in simple **closed systems**, where known forces are balanced. Again, he says, the word homeostasis *does not imply something set and immobile, a stagnation*" (1969, p.61).

(Let us remember how necessary it is to distinguish **open, closed and isolated systems** from each other – see corresponding entries).

L.von BERTALANFFY interpretes CANNON in the following way: "Homeostasis according to CANNON, is the ensemble of organic **regulations** which act to maintain the **steady state** of the **organism** and are effectuated by **regulating mechanisms** in such a way that they do not occur necessarily in the same, and often in opposite, direction to what a corresponding external **change** would cause according to physical laws. The simplest example is homeothermy" (1962, p.6).

Shortly, homeostasis is a dynamical property entailing an uninterrupted **sequence** of transient quasi-**equilibria** around an **optimum**, and not a static **equilibrium** that could be reached once and for all.

KÖHLER states: "From the point of view of physics it is, therefore, simply impossible to state it as a **rule** that **transformations in organisms** occur in the direction of **equilibria**" (ibid.).

It should however be noted that the final **state** of a system, when it becomes unable to produce adaptive **fluctuations**, is a static **equilibrium** (rigor mortis), in any case absolutely transient, since it is immediately followed by a **process** of decomposition and scattering of the **elements**.

As noted by St. BEER: "One of the key features of any **viable system**, and a sure index of its submission to **control**, is that it can maintain a homeostatic **equilibrium**... And this is surely true also of the industrial, social and economic systems with which managers have to deal" (1968, p.289).

In relation to homeostasis in **social systems**, we find in the MERRIAM – WEBSTER Dictionary the following definition: "A tendency toward **maintenance** of relatively **stable** social conditions among **groups** with respect to various factors (as food supply and **populations** among animals) and to competing tendencies and powers within the body politic, to society, or to culture among men" (1961, p.1083).

However, some of the greatest question marks of our time are: Are our contemporary societies still homeostatic, at least up to a point? Will they become homeostatic again in the future? And if not, what could be the outcome of our present **instabilities**?

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1575

HOMEOSTASIS: its ways and costs¹⁾

Homeostasis is obtained through **regulation**.

W.D. GROSSMANN and K.E.F. WATT explains: "A **feedback loop** is the classical example of homeostasis. Two types of homeostasis exist. One happens within the existing **structures** and is actually generated by these **structures**, in particular by **feedback processes**" (1992, p.10).

Repeated **feedback processes** implies the existence of a **regulator**.

The same authors pursue: "The other is a reaction by the system which causes a **change** in the systems **structures**" (Ibid).

This case corresponds to the progressive institution of the **regulator**.

Still: "The capability for homeostasis is enhanced, the shorter the **time-lag** from the moment the system experiences a **perturbation** or threat to its **viability**, to the moment it respond appropriately... The speed with which systems can respond depends on the availability of **resources** to perform the **response**" (Ibid). This corresponds to VENDRYES' concept of "**reserve**".

Homeostasis does not of course come free. The different needed types of **regulations** have an **energetic cost**.

H. ODUM expresses it this way: "Some **energy** must go into **storages** which may be necessary for **structure** or for smoothing out fluctuating power supplies. Some **energy** must go into the work of gathering **input flows**, and some **energy** must insulate and control the relation of other **circuits**. Special **energies** overcome special **limiting factors**, such as material shortages, poisons or the seasonal **fluctuations**. Finally, special **energies** may be required to pump out excess **wastes**. (1971, p.88).

However, homeostasis is merely the **behavior** of **dynamically stable systems**, generally mature ones. Systems in course of **differentiation**, **dissipative structuration**, **bifurcation**, **emergence**, etc... are definitely *not* homeostatic, and the use of the concept in these cases lead to gross misunderstandings. This point was already made by L.von BERTALANFFY in his book "General Systems Theory" (1968)

Two other concepts complement homeostasis. One, which did not become widely accepted, was W. CANNON's **heterostasis**. The other one is C. WADDINGTON's **homeorhesis**, applied to systems in their period of **growth** towards maturity.

1576

HOMEOSTASIS²⁾⁵⁾ (A critical view in relation to chaos)

In biology, homeostasis should possibly be relativized.

Marc BUCHANAN writes: "Homeostasis holds that when the body is pushed out of balance, it will compensate as to maintain **equilibrium**. In a sense, this does happen in the heart - it is the dynamic behind the long range anticorrelations discovered by PENG and his colleagues. But in the homeostatic view, the healthy **state** of the body tries to remain in a **static equilibrium**. So the heart rate should stay constant, as should blood pressure and other physiological **variables**".

This is probably a too narrow understanding of homeostasis. In opposition to **constancy**, homeostasis equals "**fluctuations** within **limits**".

Within such **limits** "the **fluctuations** are highly irregular, though far from **random**" (1998, p.25).

"But why should health be equated with irregularity? For one thing, it could make the **organism** more adaptable. A **chaotic system** is poised in a **state** in which it is very sensitive to small influences. That make it easy for the heart to respond quickly and flexibly to changes in the demands of the body" (Ibid)

Thus, with a closer look, homeostasis is a **chaotic phenomenon**, i.e. only **deterministic** in a broad sense.

1577

HOMEOSTAT²⁾

A device created by W.R. ASHBY to demonstrate some properties of the **ultrastable systems**.

In St. BEER words: "The Homeostat is precisely a machine for settling down again after it has been disturbed" (1967, p.117). As such a property is very general in **complex systems** which must "cope with an unpredictable **environment**..." (conveying) **random information**" (p.118), the homeostat can be considered a **behavioral modelling** device of considerable interest. In effect, "we are returned to the old issue of **machine design**, and that of **adaptive behavior** to **situations** not envisaged by the designer" (Ibid).

ASHBY gives a complete description of this "**machine**", whose main points are that: "The homeostat consists of four units, each of which carries on top a pivoted magnet. The angular deviations of the four magnets from the central positions provide the four main **variables**" (1960, p.100)...

Each unit may take 25 different positions and its **outputs** are transmitted in a randomized way to the other units and influence their **activity**, thus providing 25⁴, i.e. 390.625 combinations of **parameter-values**.

ASHBY explains that: "The **field** of the four main **variables** has only one **state of equilibrium** (at the centre), which may be stable or unstable. Thus the system is either stable and self-correcting for small impulsive displacements to the needles, or unstable and self-ag-

gravating, running away to the **limits** of the throughs. Which it will be depends on the quantitative details of the primary **feedbacks**, which are dependent on the values on the **step-mechanisms**" (p.104).

As stated by E.von GLASERSFELD, ASHBY's device would gradually **learn** to "... make appropriate **connections** by **learning** on the basis of its own experience which **activities** help to reduce which **error-signals**" (1988, p.117).

However, as stated by St. BEER: "... if a homeostat in an equilibrial **state** is bombarded without respite by **wave** after **wave** of **input data**, it will go into an **oscillation** from which it can never recover... if the **periodicity** of the **input** is very much faster than the **cycle time** of the homeostat itself, then clearly it has no opportunity to settle" (1968, p.384).

Thus, either the **periodicity** of the **input** must be extended or, if it can be proved repetitive, an adaptive **algorithm** must be evolved.

Numerous **behaviors** of many kinds of systems can be mimicked on this not too complicated device, as for example the tendency to **stability** or **instability**, the ways of **training**, some failures of **adaptation**, etc...

The homeostat, which is now somewhat forgotten, could still probably be very useful.

On the semantic convenience of the name "Homeostat", ASHBY wrote: "It was given the name of "Homeostat" for convenience of reference, and the noun seems to be acceptable. The derivatives "homeostatic" and "homeostatically", however, are unfortunate, for they suggest reference to the **machine**, whereas priority demands that they be used only as derivatives of CANNON's "**Homeostasis**" (1960, p.100).

1578

HOMOGENEITY¹⁾

Quality of a group of **elements** which are all of the same nature and endowed of a similar behavior.

No **concrete system** can be totally homogeneous. Only the abstract "**isolated system**" after its full entropization could reach total homogeneity.

As the state of maximum homogeneity corresponds to the maximum **level** of **entropy**, and a total **independence** of the **elements**, a maximum of **information** should be required to obtain a full **knowledge** of the **state** of the **set** of all the **elements** at some moment. This is the basic reason why an inverse relation between **information** and **entropy** could be stated and established by various authors, as Cl. SHANNON and L. BRILLOUIN.

In **concrete systems**, the 2nd. law of **thermodynamics** is always finally prevalent, leading to homogeneity in the system... and its final demise and **dispersal**, i.e. its reduction to uncoordinated **elements**.

This final **state** of entropization is an **attractor** for the system.

However, in complex systems, local **states** of relative homogeneity may exist in **subsystems**, reflecting **dynamically stable functions**. St. KAUFFMAN propose to call these states "internal homogeneity **clusters**" (1993, p.203).

1579

HOMOLOGY²⁾ - 5)

The correspondance of **elements** or **subsystems** within different systems.

This concept is translated from mathematics to systemics. It can be used to track possible functional or structural partial **isomorphies**, but this should be done carefully, because homologies can be more apparent than real.

Their use was however proposed by L.von BERTALANFFY.

1580

HOMOMORPH²⁾

A **model** that differs from another only with respect to detail. (after G. PASK, 1961, p.32)

G. PASK states, curiously: "Now, the second homomorphic **model**, is also the **observer's** eye view of an **observer** who had thrown away some of the available **information** (in a carefully calculated manner, so that his **image** is less detailed than but consistent with the original)" (Ibid).

The construction of homomorphs is an **observer's** business. Moreover, homomorphs should never be mistaken for **isomorphs**, a quite rarer type of **models**.

1581

HOMOMORPHISM²⁾

A many-to-one **mapping** of some characteristics of a **concrete system** onto a **model** of the same.

An homomorphism is an imperfect, partial or limited **isomorphism**. K. KRIPPENDORFF writes: "Homomorphisms are important in establishing whether one system is a **model** of another and which properties of the original of the system the **model** retains. For each system one can **construct** a **lattice** of homomorphic simplifications" (1986, p.36).

G. KLIR explains: "An homomorphic relation between two systems is contingent upon a **function** from relevant entities of one system (the original) onto the corresponding entities of the other system (the **modelling** system) under which the relation among entities is preserved. If the **function**, which is called a homomorphic **function**, is **bijective**, the relation is preserved completely (we say that the two systems are **isomorphic**); otherwise it is preserved only in a simplified form" (1993, p.30).

The last case is by far the most common.

R. VALLÉE, refering himself to the example of "the **map**, which is not the territory" (KORZYBSKI) states: "The **map** is not supposed to provide useless details. Homomorphism is enough, and the degree of accuracy of a **representation** ought to be adapted to the purpose for which it has been chosen: **cognition**, action or any other end" (1991, p.4).

V. TURCHIN makes the suggestive comment – helpful in placing **models** in proper perspective – that: "A **model** is a family of homomorphisms" (1993, p.7).

1582

HOMOPLATY²⁾

The condition of a **region** of **space** that is about as broad and as long as possible.

This notion was introduced by L.F. RICHARDSON.

"The geometric figure which satisfies completely the property of 'homoplasy' is the circle. It is known, however, that a two-dimensional region cannot be divided into contiguous circles" (1961, p.139).

In such a space, the closest approach to homoplasy is obtained by hexagonal **clusters**. See: (two dimensional) "**space structuration**". This has very important implications for **space** occupancy in general ("**hexagonal space filling**").

1583

HOMOTOPY²⁾

Property of two **paths** in a **topological space** that can be deduced from each other by continuous deformation.

The main interest of this concept is to allow for comparisons between **forms** which could seem at first sight unrelated.

Homotopic deformation has been extensively used by d'Arcy W. THOMPSON in his famous work "On **growth** and **form**" (1916, 1952). THOMPSON applied it to comparative anatomy and phylotaxy, but also to the mechanical **structures** in bridges and other constructions and, generally, to the study of the relations between **forms**.

Homotopy is a special case of **homeomorphism** and **isomorphisms**

1584

HORA and TEMPUS parable¹⁾

A parable about two watchmakers, by H. SIMON showing the conditions for the **evolution** of **complex systems**, demonstrating that "... a system composed of independent stable **subsystems** can withstand **perturbations** to a significantly higher degree than systems build directly from their **components**" (1974, p.223).

In short, interconnecting pre-ordained **subsystems** is a more efficient way to construct a complex **entity**, rather than to do it from a mere mass of unrelated **elements**.

→ **Evolution of complex systems; Modularity (Weak); Module**

1585

HUB¹⁾²⁾

A **node** in a **network** linked with many other **nodes**.

Hubs are important because they ease long distance **communication** in the **network** by reducing the number of intermediate steps needed to connect any **node** with any other one.

(see "**small world**") Each hub becomes a concentration and distributive center for **information** in the **network** and contributes to its structuration. Hubs are a basic feature, specially in Internet to which they provide innumerable short cuts, simplifying and accelerating **communication**. Thus, hubs are not merely static **elements**, but are also basic in **dynamics**.

Hubs can be found in many different classes of networks. D. COHEN for ex., writes: "Food webs – the networks of who eats whom in various **ecosystems** – are built around "hub species" that eat large number of different prey species..." (D. COHEN, 2002). Hubs are also basic in human societies: A scientific journal, for instance, can be considered a hub for the world diffusion of specific **information**, among widely separated **groups** working on related subjects.

Also, in the propagation of **epidemics**, some individuals, in particular promiscuous ones in the case of AIDS, may be viewed as hubs, who can easily created new foci in very distant places. Cohen even writes: "... the way HIV spreads through **populations** is similar to the spread of viruses on the Net". Hubs are also important in **graphs** used in social psychology to describe interpersonal **relationships** within and among **groups**. In short, hubs are all-important in terms of multiple social **interconnections** of any kind.

As a basic organization feature, hubs are also somehow related to ASHBY's **constraints**.

The number of hubs in a **network** is related to the number of **nodes** by a **power law**: there are much less hubs than common **nodes** and the most connected hubs are also the less frequent ones (See D. WATTS, 1999).

An unfortunate feature of highly connected hubs is that their accidental or wilful destruction, sometimes at one stroke, can impair or even destroy the whole network. Examples are widespread blackouts in interconnected electrical grids, or extensive functional impairment as a result of a cerebral haemorrhage

The notion of Hub has been considered in its most general sense by A.L. BARABASI (2002).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The word "**neurode**" is used in a quite closely related meaning.

1586

HUMAN ACTION SYSTEM ⁴⁾

A general model for human activities.

The general idea of such a **model** is proposed by R. RODRIGUEZ DELGADO who writes that it "would be necessary in each case to conceive a Human Action System, its **interrelationships**, its adequacy to different **environments**, and the possibilities of applying the generalized **principle of complementarity** to problems that at first view appear as antagonistic or conflictive" (1990, p.7).

1587

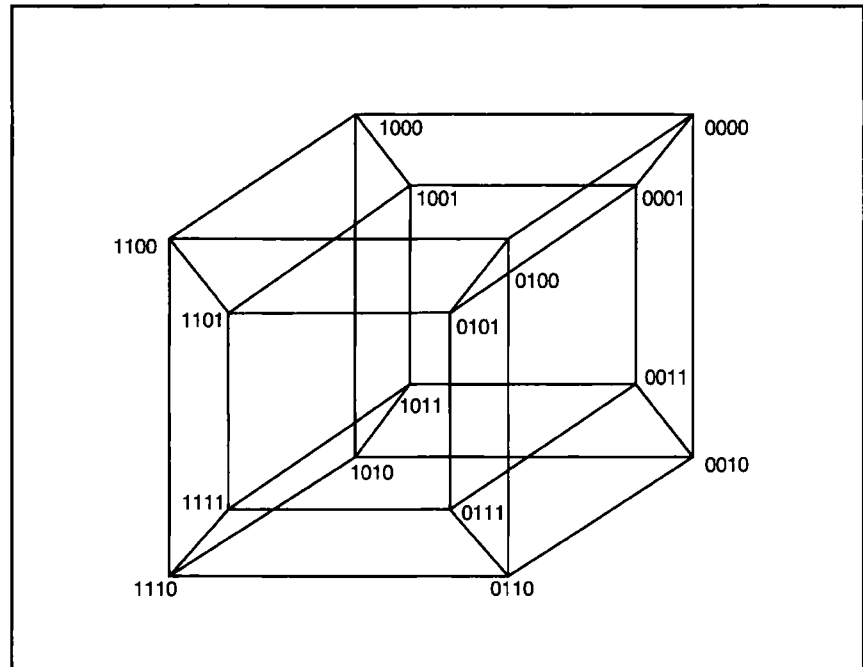
HUMAN ACTIVITY SYSTEM ⁴⁾

P. CHECKLAND introduces this **concept** in the following way: "The system "man" is crucial because of man's ability, as tool maker, myth maker and doer, to change his **environment** and his circumstances within it. Given man and his abilities, we have the huge area of "human activity systems", from the one-man-with-a-hammer... to the international political systems which we shall have to forge if life is to remain tolerable for the human race on this finite planet...

"Human activity systems must be designated in two different ways. Firstly there are the physical collections of **components** which are the structural **set** which makes the system; and secondly, because of the nature of the human **component**, there are the activity systems which are concerned with processing **information**, making plans, carrying out operations, monitoring **performance**, taking **control action**, taking leisure, finding things out, and so on" (1972, p.52).

B. BANATHY introduced a still wider embracing **concept** of "Human activity system" in 1987. He described it as follows: "Human activity systems, such as **organizations** and social systems, can give direction to their **evolution** and shape their future by engaging in **design** inquiry. They can enhance their continuous **development** and improve their effectiveness by purposeful **design**". He understands design as "creative, decision-oriented, disciplined inquiry that first clarifies the reason for engaging in **design**: then diagnoses and describes the **design problem situation**; formulates expectations, **purpose** and requirements of the system to be designed or redesigned; generates and clarifies alternative **representations** of the system that can meet those requirements and expectations; devises **criteria** by which to evaluate those alternatives; and prepares a plan for the **development** and im-

Figure: see entry **HYPERCUBE ARCHITECTURE**



The Hypercube as a 4-dimensional connection model
From S. KAUFFMAN: 1993, p. 38

plementation of the selected **design**" (1987, p.54).

These **concepts** and proposals are developed by the **FUSCHL Group**, whose endeavor is to translate them to the **transformation** of real systems.

The general methodology (**co-participative design**) is close to J. WARFIELD's **Generic Design**.

- Three factors seem of particular importance:
- A careful study of the **situation** as it is and of the causes that led to it (in order to avoid any problem of **underconceptualization**).
 - The avoidance of ideological illusions, which very easily creep in idealistic groups unaware of their own biases.
 - The necessity to promote the effective participation of all the members of the group interested in the **design** and its results.

K. BAUSCH, in turn gives the following definition: "A **designed** social system organized for a **purpose**, which they attain by carrying out specific **functions**" (K. BAUSCH, Glossary, pers. comm., 2002)

Of course, the relation between the purpose (or purposes) of the social system and its design is crucial. In particular, there is wide difference between a system designed by an individual (the "boss" or "bosses") for own purpose and another system designed by a **conversation** group of would be **stakeholders**.

For now and for any practical purposes, this is the first type of human activity systems completely predominates (with only the peculiar case of religious **groups** or charities)

1588

HUMAN SYSTEMS (Rule-bound)

→ Rule-bound human systems

1589

HYDROSPHERE ¹⁾²⁾

The portion of the earth's crust covered by water

It includes not only the oceans, but also the lakes and rivers and in a sense the polar ices and the aquifers

→ **Atmosphere; Biosphere; Ekistics; Lithosphere; Sociosphere; World-engine**

1590

HYPERCUBE ARCHITECTURE ²⁾

A way to organize complex **interconnections** between **elements** in a multi-dimensional **space**.

... or, in a more formal fashion: A **structure** of **interconnections** among **elements**, selected by chosen **constraints** applied to the **set** of all possible **interconnections** among the vertices of a n-dimensional hypercube.

In a 4-dimensional Boolean hypercube, for example, a possible **constraint** is to admit direct **connexions** of any vertex with only its four direct neighbors. In this case, the **communication** with any other vertex demands at most four steps (through at most three intermediate **vertices**).

The hypercube architecture is a basic **model** for massively **parallel processes** between very numerous and interconnected **elements**.

D. HILLIS original **connection machine** is constructed around an **interconnection network** based on a 12 dimensions hypercube geometry allowing the **interconnection** of 4096 **nodes**.

see figure previous page 287

1591

HYPERCYCLE^{1) - 2)}

A self-reproductive **catalytic reaction cycle** made of sequentially interconnected **replicative sub-cycles**.

In M. EIGEN and P. SCHUSTER words: "A catalytic hypercycle is a system which connects **autocatalytic** or self-replicative units through a **cyclic linkage**". More precisely: "... it consists of self-instructive units I_i with two-fold **catalytic functions**. As **autocatalysts** – or more generally – as **catalytic cycles** the intermediate I_i are able to instruct their own **reproduction** and, in addition, provide **catalytic support** for the **reproduction** of the subsequent intermediate" (1979, p.5).

And, in more general terms: "The hypercycle is the tool for integrating length-restricted self-replication entities into a new stable **order**, which is able to evolve coherently. No other kind of **organization**, such as mere **compartmentation**, or **non-cyclic networks** could fulfill simultaneously all three of the following conditions:

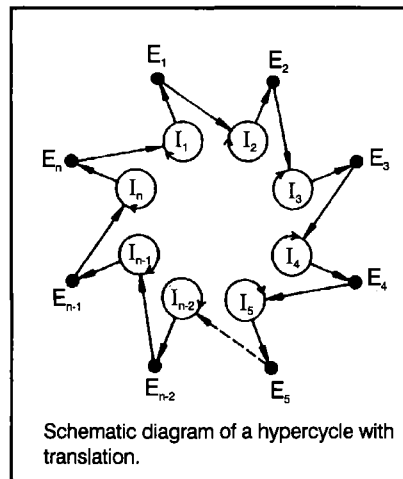
- to maintain **competition** among the wild-type **distribution** of every **self-replicative entity** in order to preserve their **information**;
- to allow for a coexistence of several (otherwise competitive) **entities** and their mutant **distribution**, and
- to unify these **entities** into a coherently evolving unit, where advantages of one individual can be utilized by all members and where this unit as a **whole** remains in sharp **competition** with any unit of alternative composition" (p.VII).

In St. KAUFFMAN's word: "... the mutually cyclic **connections** among **template** pairs, which are themselves already **autocatalytic**, constitute a higher **order** hypercycle, coupling such **autocatalytic** units" (1993, p.359). While elemental units are subject to possible errors, "the hypercycle as a whole is not" (Ibid).

This suggests an explanation to von NEUMANN's **reliable networks** out of **unreliable components**.

The hypercycle could be defined as an "**eigen-transitions**" process, in von FOERSTER's style, linking the hypercycle with **autopoiesis**. It also seems to correspond to H. HAKEN's **order parameter**. The whole process can be represented through the following graph

As observed by E. LASZLO: "The **loop** may involve a large number of **elements**, but it ultimately closes in upon itself, forming a remarkably fast and stable reaction **cycle**" (1992, p.243).



The Hypercycle.

From M. EIGEN and P. SCHUSTER: 1979, p. 50

Hypercycles are a very general constructive and reproductive **organization model**. They obviously open the road to the build-up of **complexity** at successive evolutive levels.

The global **organization** of the hypercycle implies necessarily a **hierarchical order** reflecting an ordered **cooperation** among mutually replicating **elements**.

1592

HYPERHISTORY¹⁾

Arno Peters (1916-2002), a german historian, developed in 1952, the "synchronoptic" model of world history, whose main goal is to produce the "visualization of the concurrent" in history.

His model included 3000 facts related to all main human activities: science, culture, religion and politics.

This allowed probably for the first time a general synthetic and integrated view of mankind general evolution. It is an important tool to construct a systemic understanding of the whole subject.

Moreover, the model is useful to eliminate the biases that result from culturo-centrism.

1593

HYPERINPUT

→ Cellular Automation

1594

HYPERSPACE^{2) - 5)}

A **space** with more than three dimensions.

These abstract **spaces** can be used to represent the potential **interrelations** and **configurations** among numerous **elements**, but apart from the **hypercube**, they are practically impossible to visualize.

1595

HYPERSTATE

→ Cellular Automation

1596

HYPOSTATIZATION³⁾

"Reification of some **order** intrinsic to the mind" (J.W. SUTHERLAND, 1973, p.57).

It became clearer in the recent years that there is indeed some intrinsic **network organization** in the **brain** (let us be careful with the concept of *mind*).

SUTHERLAND explains in this way the origin of mathematics and consider that "... a similar claim for a priori ordering of some kind may be made with respect to CHOMSKY's postulation of immanent 'deep structures'".

Our access to reality is thus here again depending on the nature of the basic tool we must use to study it: our brain and our nervous system.

1597

HYPOTHESIS (Cross-level) method

See "Cross-level research in living systems"

1598

HYPOTHETICALITY¹⁾³⁾

The nature of "**situations** in which we have to make life-or-death **decisions** but are unable to perform the **experiments** or tests needed to gain much-needed **information** about the **situation** before having to make the **decision**". (J. CASTI, 1997, p.8 - after Wolf HAEFELE, former director of the German Nuclear Research Center in Juelich).

The **situations** alluded to are complex ones, in which an important number of elemental **processes** in **interaction** should be considered **simultaneously**. In such cases the **dynamics** of the situation generally becomes **chaotic** and **predictability** is possible only within the limits of a statistically reduced **determinism**.

In J. WARFIELD words, our problem in such cases is to "transform **complexity** into **understanding**" (1999, work in progress, pers. comm.)

→ Christmas tree effect

1599

HYSTERESIS^{1) - 2)}

The property of a system which does not return to its original **state** when submitted to a **variation**.

N. RASHEVSKY explains that hysteresis result of the fact: "... that the properties and **reactions** of a system are determined not merely by its present surroundings but also by the conditions of these surroundings at previous **times**, or, in other words, that those properties are determined by the past history of the system" (1960, p.69).

The classical example of hysteresis in physics is the failure of a magnetized body to return to its former level of magnetization when the value of the magnetic **field** is reduced.

However the phenomenon is very general. RA-SHEVSKY states: "From this point of view, various **phenomena** in the central nervous system, such as those connected with **learning**, **adaptation**, etc. are merely complex forms of hysteresis" (Ibid).

This connects the subject with **autopoiesis**.

R. ROSEN explains: "A system exhibiting hysteresis has the capacity to "remember", in a certain sense, that it was exposed to a **parameter variation**, in that the **behavior** of such a system will generally be different from that of an identical system which was not exposed to the **parameter variation**. Indeed, in biology hysteresis has often be used, implicitly or explicitly, as a **model** for **short-term** or **long-term memories**".

Of course, there are no "identical" systems, but this **semantic** lapse does not annulate ROSEN's argument.

He states, moreover, that it is often possible to "erase" the **memory** of such a **perturbation** "... provide we can reduce the **parameter P** sufficiently *below* the original value $P = P_0$; this gives rise to the well-known concept of the **hysteresis loop**. But it is by no means always possible" (1974, p.98).

I

1600

ICON³⁾

"A **sign** which would possess the character which renders it significant, even though its **object** had no existence" (C.S. PEIRCE, in J. HOOPES ed., 1991, p.239).

PEIRCE gives the following example: "... a lead-pencil streak as representing a geometrical line" (p.239).

Icons have, or acquire quickly, a symbolic character, which easily elicits a **variety** of possible reactions in people, even at the level of **conditioned behavior**.

Examples of icons are the red cross, the national flag, the Ying and Yang symbol, etc.

Some icons in history have been used with well defined **purpose** of political and psychological manipulation, as for example the svastika or the hammer and sickle.

The icon has always a diagrammatic character (p.181) and "partakes of some more or less overt character of its **object**" (p.252).

As such, PEIRCE considers that it somehow has the character of a fallacy, or a **metaphor**. This is important for systemics, in order never to forget that "the **map** is not the territory", or the **model** is not the entity it seeks to represent.

1601

IDEA¹⁾³⁾

"The smallest unit of mental process" (G. BATESON, 1979, P. 228)

This is in Bateson's view the "**difference** or distinction or news of a difference" (Ibid)

He adds: "What is called an idea in popular speech seems to be a complex **aggregate** of such units. But popular speech will hesitate to call, say, the bilateral **symmetry** of a frog or the **message** of a single neural impulse an idea (Ibid)

Truly, the "idea" of what an idea is appears to be quite **fuzzy**. The word in itself is in fact a **label** stuck on a still insufficient understanding of our **cerebral processes**.

1602

IDEAL TYPE

"An intellectual **construct** to aid thinking (Hence an **epistemological** concept)" (R. RODRIGUEZ ULLOA, Glossary, 1999)

An ideal type is thus "not a **description** of something in the real world... The word "ideal" is not **normative**, the function of ideal types being to enable comparisons to be made and theories to be developed... (even if) they are usually constructed from empirically observable or historically meaningful **components** - for example the individual **activities** in a **human activity system**" (Ibid).

In synthesis, "ideal" is about ideas, not about **ideology**.

1603

IDEALIZATION (Spurious)³⁾

"The reification of highly reduced concepts" (D. Mc NEIL, pers. comm.)

As examples of this type of mental trap, Mc NEIL lists: "... dimensionless points, perfect planes and straight lines and **linear** dependencies and independent **objects**" (Ibid). One of the main efforts of systemics is to try to create less reduced **models** of concrete **objects** and **situations**... and to become clearly conscious that they are still *models* of reality, only hopefully somewhat less artificial.

1604

IDEAL-SEEKING SYSTEM^{3) - 4)}

A system able to pursue **truth**, or ultimate good, or any other **value**.

This concept, as derived from the notion of **purposive system**, represents very well the idealistic current among systemists, i.e. basically E.A. SINGER Jr, C. W. CHURCHMAN, and their followers. Since the **meaning** given to "truth", or "good", or "beauty", or any other supposedly absolute **value**... can be very variable according to different proponents, the ideal-seeking system concept is necessarily somewhat controversial in the ways it is used.

Moreover, there are differences between those who believe that individuals *and* societies can be ideal-seeking (R.L. ACKOFF) and those who consider that only individuals can be (F.E. EMERY).

This last author, as quoted by G.A. BRITTON and H. McCALLION (1994, p.497 - principal source of this entry), "postulates the following characteristics of ideal-seeking systems:

"1) Only individuals can be ideal-seeking systems

"2) Individuals can sustain the ideal-seeking state only temporarily

"3) Ideal emerge only within **group** life.

"4) No ideal can be pursued single-mindedly without sacrifice of the others.

"5) The essence of wisdom is deciding on what sacrifice of other ideals should be made in any particular **choice** between **purposes**" (p.497).

Even this quite matter-of-facts statement cannot dispel doubts about what happens when encountered ideals (within the same ideal-seeker, or still more so, among various ones) are coming in opposition. Moreover, ideals are most frequently convenient fodder for **ideology**.

In any case, a good systemic **description** of the roots of ideal-seeking as a commonly observed **behavior** would still be very useful: how and why it appears, and how it operates in the mind of the ideal-seekers.

1605

IDEAL-TYPE^{2) - 3)}

"An **abstraction** which emphasizes certain properties which are felt to be distributed among real-world entities, and emphasizes them in such a way as to produce a highly directive and normative **model**" (J.W. SUTHERLAND, 1973, p.44).

According to SUTHERLAND, "The **model** is directive (if not operationally, at least experimentally) in that it provides the major premises from which some logical conclusions may be drawn" (Ibid).

The use of ideal-types is subagent to any **taxonomy**: "... an ideal-type is one **element** in an array of ideal-types which, as a **set**, constitutes a proper **taxonomy**". (Ibid., p.45).

One should always be careful not to confuse ideal-types for the **entities** they represent. For the way ideal-types are constructed, see KORYBSKI's **Structural differential** (1950).

Of course, in SUTHERLAND's words: "...**taxonomies** and ideal-types are themselves theories" (p.68).

SUTHERLAND distinguishes mechanical and organic ideal-types (p.97).

1606

IDEAL-TYPE (Mechanical)^{1) - 2)}

SUTHERLAND describes as follows the characteristics of the mechanical ideal-types:

"Interface conditions: Usually exist within well-defined, tangible **boundaries** which may be adjusted **endogenously** for greater or lesser **selectivity** with respect to entering or exciting forces.

"Structural characteristics: Generally has its **components** arrayed in a neat, observable **hierarchy**, such that properties at one **level** tend to be extrapolations of properties at other **levels**, with **relationships** among the various **levels** being essentially **deterministic**.

"Dynamic properties: **Parts** are usually highly **constrained**, having only a limited **repertoire** of **responses** permitted to them; causal **trajectories** and **paths** of **interaction** are generally fixed, controllable and exclusive; driving forces are generally tangible and measurable.

"Normative analytical properties: Potentially **total**:- **observability** – measurability – manipulability – **predictability**.

"Amenability to inference and induction: Given **initial state conditions**, future **states** may be induced with a high probability of accuracy" (1973, p.97).

1607

IDEAL-TYPE (Organic)^{1) – 2)}

According to SUTHERLAND, the characteristics of organic ideal-types are as follows:

"Interface conditions: Highly **open** with respect to **environment** and **exogenous** forces. External determinants which affect the system may, therefore, be too far removed (spatially or temporally) to be analytically observable at any point of **time**.

"Structural characteristics: **Parts** are not arrayed in a neat, stable **hierarchy** but **stochastically**, with the **structure** and direction of interrelationships generally altering almost constantly in response to localized **changes** of **environmental** influences, etc.

"Dynamic properties: **Parts** have potential for inaugurating opportunistic or strategic **behavior** in response to local **parameter changes**; causal **trajectories** may be altered locally and **interactions** may be **equifinal**; dynamic (driving) forces may be transparent rather than tangible and manipulable.

"Normative analytical properties: Only **partial**:

- empirical inaccessibility
- immeasurability
- imperfect controllability
- **unpredictability**

"Amenability to **inference** and **induction**: Future **state** conditions cannot be successfully inferred from **initial state** conditions" (p.97).

1608

IDENTIFICATION (Spurious)¹⁾

The abusive identification of any **model** with the **concrete system** it claims to represent.

As a matter of fact, rigorous identification seems to be always spurious, with the possible exception of completely abstract **isomorphisms** obtained from different sources.

As stated by A. KORZYBSKI, "the **map** is not the territory". No **model** can ever be complete, nor completely accurate. Moreover, **models** contain hidden assumptions and, in many cases, downright prejudices. Abusive identification may lead to erroneous and even dangerous conclusions about the real **situations**.

"Identification" is not given here the significance of "**recognizing the identity**" (see hereafter).

1609

IDENTITY¹⁾

The set of permanent characteristics of a system which allows to recognize it in different instances.

The establishment of identity is preceded by a **process** of **entification**.

The identity of a system is based on its **auto-poietic relations of production**, which leads K. KRIPPENDORFF to define it in a seemingly dubious way, as: "A **transformation** always reproducing the original" (1986, p.27).

Even in this sense, identity is thus merely the persistence in **time** of the basic characteristics of the entity (See hereafter).

Absolute identity between **two** or more **objects** is obviously impossible, as it would imply perfect coincidence of their spatial and temporal characteristics. Identity in this sense is possible only among **abstract** entities.

1610

IDENTITY TRANSFORM²⁾

"... The condition where the representative point of the system is trapped in a single **confluent**" (St. BEER, 1968, p.477).

BEER explains: "That is a lethal state of affairs; the system can no longer adapt: however much it is stimulated, and however often the point leaves **equilibrium** in E., it always returns. This is the **model** of over-specialization, of **obsolescence** leading to extinction and death" (Ibid.).

Systems reach this condition when the amount of **redundancy** contained in their original **program** becomes nearly exhausted. This is closely related to **ageing** and **equifinality**, and also to a dwindling **amplitude** of **homeostatic fluctuations**. All of these **effects** reflects the finally unavoidable increase of **entropy** in the system.

While BEER refers himself more specifically to human **organizations**, the **concept** may also be applied to biological systems.

1611

IDEOLOGY^{1) – 3) – 4)}

A body of statements tending to impose **values**, beliefs and **behavioral norms** in a **social system**.

Ideologies tend to having an **internal** rationality, becoming impervious to any concept or even **event** that does not seem to fit within their limits. They are **regulation mechanisms** and can, during long time, foster cultural **identity**. They nonetheless may impair the **perception** of discrepancies or **changes** and finally lead the system to a critical **threshold** of **instability**.

1612

IDONEITY³⁾

Fitness, or relevance of **models** and theories, in relation to reality.

This concept was developed by the Swiss epistemologist F. GONSETH in his epistemological study of the evolution of geometry in the 19th and 20th Centuries. It has been reintroduced by E. SCHWARZ (1994 b, p.581).

1613

IF – THEN

→ **RULE (If – Then)**

1614

IIASA

→ **International Institute for Applied Systems Analysis**

1615

IMAGE^{2) – 3)}

A physical or mental **representation** of some **object** or system.

Physical **representations** are generally "**iconic**", made to be seen. Mental **representations** are proper to each individual. Image formation is, at least in man (if not altogether in superior animals), a basic condition for coordinated **action**.

In J.P. CHANGEUX words, images do result of the "...integrated workings of a **perception mechanism** of mental **objects** and of monitoring or their **connections**" (1992, p.709)

When the **relationship** between mental and psychic images and the relevant **environment** is unsatisfactory, **action** turns inefficient, and in some cases outright pathological, in particular when the image is confused with what we call reality (A. KORZYBSKI, 1950a). Images are a fertile ground of **metaphors** and **analogies**, sometimes unfortunately dubious or spurious.

As observed by K. BOULDING (1956), mental images have an imaginary temporal dimension, when referred to past **events**, even those historical ones whose images had to be learned, being built up through **semantic** or **symbolic messages**: None of us ever knew personally

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

Julius CAESAR, but we assembled an image of him, learned from historical records, transmitted through successive generations... and very probably quite inaccurate in some aspects.

1616

IMAGES: their meaning in societies²⁾⁴⁾

K. BAUSCH describes as follows the present nature and **role** of images in societies. Thereafter he presents a proposal for their use as a possible tool for social **transformation**, as elaborated by a growing group of systemists concerned with better working human societies. BAUSCH starts by defining "images" present meaning: "The subjective and intersubjective **knowledge** (i.e. what we believe to be true or possible) that guides individual **behavior** and shapes collective **culture**" (Glossary-Per-s.comm., 2002)

He explains: "Images of humankind which are dominant in a culture are of fundamental importance, because they underlie the ways in which the society shapes its institutions, educates its young, and goes about whatever it perceives its business to be. The image represent our current **perception** of the past, present and future.

Our social realities and our images coexist in mutually adapting **interaction**" (Ibid)

These are the images that we have and use. Could we change this scheme purposefully? Hereafter BAUSCH's opinion. "The **purpose** of an evolutionary image is to guide out attention toward a desirable future-rather than to try to predict the future based on an **extrapolation** from past and present **events**. An evolutionary image of the future is an invitation to become **aware** of the consequences of our present **choices**, and more importantly, to participate in the creation of the future. The absence of such an image restricts the human potential and our future possibilities" (Ibid).

However, the use of valorative terms (believe, true, desirable), which are culturally tainted, and the possible effects of their use, should be closely scrutinized. This is specially important as we are now in a **process** of multi-cultural debate as a result of so-called **globalization**.

1617

IMITATION^{3) - 4)}

Acquisition of a **model** for **behavior** by **perception** of the **behavior** of another **organism** (after D.T. CAMPBELL, 1961, p.18).

Imitation is also, obviously a mode of social **learning**.

Not only people, but also many animals acquire some typical behavior by imitation, which is generally basic for most of the process of **learning**. E. CURIO even managed to induce sequential imitation among blackbirds, of an initially conditioned behavior in a first bird of the group (L.A. DUGATKIN, 2000, p.55).

Simple imitation of some specific behavior is not sufficient however to explain transmission of **culture** (H. PLOTKIN, 2000, p.60). But this transmission supposes such individual and elemental steps as a first basic repeated **process** covering the acquisition of the numerous correlated traits that make up a **culture**.

→ **Time binding**

1618

IMMERGENT PROPERTY^{2) - 4)}

A property of an **element** or **subsystem** that becomes concealed at a higher **level** in the system.

A good and simple example is the concealment of the specific properties of the oxygen atom or molecule within the H₂O molecule. Immergent properties are a natural complement of **emergent** ones.

Immergence is a general characteristic of all **elements** entering in combinations within more complex units: it is practically a very basic social property.

1619

IMMUNITY^{1) - 4) - 5)}

The condition of a system able to resist some specific aggressions from other systems in its **environment**.

This is a generalization of the biological concept of immunity. This condition is a result from a first successful **reaction** of the system to the aggression, through some internal **adaptation**.

Immunity results in general terms from the **emergence** of a countervailing **feedback** that becomes stabilized, generally in an implicit way.

In a somewhat metaphorical way, social and cultural systems may become more or less immune to foreign influences by developing defense **mechanisms**. This is probably the unconscious aim of what is generally known as fundamentalism, as an adaptive **reaction** to psycho-cultural suffering, induced by some imposed transformation.

→ **"Resilience"**.

1620

IMPEDANCE (Active)²⁾

A device developing "...a backforce against any **input** driving force so long as that force is increased" (H. ODUM, 1971, p.39).

This could be called a device for stubborn resistance and protection. ODUM, who describes it, writes: "At the same time some **energy storage** is arranged so that when the forcing

impetus ceases, the **energy** unit delivers a forward **flow**. Many **organisms**, human **behavior programs**, and conservative institutional **programs** have stubbornness of this form" (Ibid).

1621

IMPLICITNESS³⁾

The hidden character of much of the fundamentals of our **concepts** and **methods**.

This difficulty has been emphasized by J. WARFIELD who underlined that it works against the transparency of our referentials (1988, p.340). See: **"Invisibility"**, **"Underconceptualization"**.

1622

IMPLOSION²⁾

A sudden and more or less complete inward **collapse** of a group of **elements**.

This **process** may create a system out of formerly unconnected **elements**, as for example in a star's formation; or a quasi system as for instance a locusts **swarm**. According to B. WALLISER it corresponds to the increase of the **interactions** among **elements** (1977, p.84).

It leads to growing reciprocal **constraints** through an increasing number of new associations that tend to become **correlated**, as well as **structurally** and **functionally** permanent.

It is however also possible that an excess of **constraints** could produce a more or less total freeze of the **interrelations**, leading to a kind of blockage or paralysis and ensuing destruction.

→ **Frozen core**

1623

IMPRINTING:¹⁾⁴⁾⁵⁾

A **learning** or **training process** during the early life of an animal through which a specific behavior or **behavioral pattern** is acquired through **imitation** from a parent or other member of the **social group**.

The basic **behavior** of an animal becomes fixed normally by **imitation** of its parents, or other members of the social group. Imprinting occurs only during a quite short critical **period**, during the early weeks or months of an animal.

This very general behavior has been observed and researched mainly by the Austrian Konrad LORENZ, and the Dutch Niko TINBERGEN, pioneers in ethology.

In this way, basic reactions, as for example escape from predators become deeply ingrained and automatic, which is a very important life-saving **adaptation**.

Ethology of imprinting, as a trans-generational process, opens interesting question marks on the possible existence of a wider, cultural type of imprinting in humans. Doubtless, a

whole range of **reactions** and ways of behaving are learned during human infancy. and they seem to be different from one **culture** to another.

The human being is quite probably the most deeply and widely imprinted living being, as **culture** includes not only physiological behaviors, but also transmits attitudes and **roles**

The subject would deserve a deeper scrutiny by ethnologists and sociologists, as it seems to indicate general definitory **rules** for the establishment of implicitly well defined **relationships**, even in some cases in an automatic, if not coercitive way.

An interesting line somehow related to imprinting is J.L. MORENO's sociometry, including his sociograms.

1624

IMPROBABILITY (Degree of)¹⁾

The degree of improbability of a system is proportional to the **complexity** of the **interrelations** among its **elements** and to the number of its possible **states** (**variety**). It measures the quantity of **information** that should be needed to assemble it and the improbability that could be introduced by **random** action.

Thus improbability is not related only to **synchronic structure**, but altogether with its **diachronic** variations.

1625

INCHOATE BONDING MECHANISM

→ **Bonding mechanism (Inchoate)**

1626

INCLUSION CYCLE

→ **Cycle (Inclusion)**

1627

INCOMMENSURABILITY²⁾

P. BERGÉ and M. DUBOIS state: "A **nonlinear dynamic system** that **oscillates** on three incommensurable **frequencies** may become **unstable** and show a **chaotic behavior**" (1992, p.120).

The subject of incommensurability deserves wider research because it is a bridge between **chaos** and **prime numbers**. Intertwined **periods** each with a **frequency** based on a **prime number** could be the basic characteristic of **chaos**.

This could also prove an interesting return to PYTHAGORAS and FIBONACCI.

1628

INCOMPATIBILITY (Principle of)¹⁾

This principle has been proposed by L.A ZADEH who stated it in the following terms: "... as the **complexity** of a system increases our ability to make precise and yet significant statements about its **behavior** diminishes until a **threshold**

is reached beyond which precision and significance (or **relevance**) become almost mutually exclusive characteristics".

Moreover, "A corollary principle may be stated succinctly as: "The closer one looks at a real-world problem, the **fuzzier** becomes its solution" (1973b, p.28).

Consequently, in ZADEH's opinion: "... the conventional quantitative techniques of **system analysis** are intrinsically unsuited for dealing with humanistic systems or, for that matter, any system whose **complexity** is comparable to that of humanistic systems" (Ibid).

This has been the reason why ZADEH introduced the concepts of **fuzzy** logics.

It is noteworthy that these seem to apply basically to systems whose **behavior** is **chaotic**.

1629

INCREMENTALISM (Disjoined)^{1) - 4)}

Small **changes** introduced in a system, based on inadequate **information** and **understanding** (Adapted from J.van GIGCH, 1978, p.360).

This concept has been introduced by D. BRAYBROOKE & C.E. LINDBLOM (1963), according to whom it is characterized by **decisions** "subject to constant reconsideration and redirection... typical of ordinary political life". They state that, as most political **decisions** are based on small incremental **changes**, "old programs go on to being developed into new programs as a sequence of **decisions**". Such a new program "is not a program at all; it is not a comprehensively considered and coordinated policy". Rather "it is the product of a number of small specific moves... whereby old programs are modified through... an endless stream... of **decisions**" (as quoted by J.van GIGCH, p. 360).

This kind of ad hoc tinkering is of course anti-systemic, and is the main cause of global **suboptimization**, squandering and pathological bureaucratization.

This problem is closely related to J. WARFIELD's **underconceptualization**.

1630

INDEPENDENCE¹⁾

The quality of a totally self-supporting system.

This is an abstract and quite illusory **concept**, which should be paired with the **concept** of **isolated system**. No **concrete system** can survive without **inputs** (and **outputs**) of **energy**, **matter** and/or **information**.

K. KRIPPENDORFF states that "Independent systems are closed to **information**" (1986, p.38). One wonders if such a condition is really possible for **concrete systems**. A system could be independent of others only if it has never interacted with them, and will never do.

Independence, moreover, should not be confused with **autopoiesis** and its complement **organizational closure**, which are properties allowing a system to maintain its **autonomy**, i.e. to **control** more or less efficiently its **interrelations** with its **environment**.

→ **Interdependence; Rights and responsibilities**

1631

INDETERMINACY^{1) - 2)}

Condition of a system such as "...there exist no determining formula whereby future **state descriptions** are completely and necessarily implied by present **data**" (D. Mac KAY, 1969, p.147).

Mac KAY understands that indeterminacy is a condition more extreme than **unpredictability**, which may result when a "completely determining formula" exists, but with an insufficient **knowledge** of the "relevant **initial conditions**" or insufficient computing capacity.

It is arguable if "indetermined" means "totally indeterminable". **Complex systems** with a number of independent initial **variables** (i.e. initially independent) may be submitted to a general **determinism**, which however allows for numerous unpredictable **situations** within its own **limits**.

This is the **chaotic determinism situation**.

1632

INDETERMINACY (Macroscopic)^{1) - 2)}

According to I. PRIGOGINE et al., a consequence of the **thermodynamics of irreversible systems far-from-equilibrium** is that: "... the macroscopic equations themselves contain the element of stochasticity which leads to "macroscopic indeterminacy". Problems such as **self-organization in nonequilibrium systems** require both aspects – the **deterministic** one where averages represent accurately the physical **state** of the system, and the stochastic one which is important near **bifurcation** points and **instabilities**. It is the cooperation of these two features which leads to a faithful **representation** of some of the basic aspects of evolving systems" (1978,p.72).

1633

INDETERMINACY RELATION (Heisenberg)^{3) - 5)}

In relation to the **complementarity** situation in micro-physics stating the **simultaneous** but incompatible (in the classical physics sense) ondulatory or corpuscular aspects of microphysical entities (radiations-electrons), HEISENBERG "...showed how a high precision in the determination of one property x (e.g. position) implies a low precision in the determination of a **complementary** or incompatible property p . (e.g., momentum)

$$m \cdot \Delta x \cdot \Delta p \geq h/4\pi$$

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"m is the mass of the particle. Δx is here the uncertainty in the determination of x., h is PLANCK's constant. The product $\Delta x \cdot \Delta p$ determines a volume in **phase space**. Hence, the principle (of indeterminacy) can be interpreted as saying that no **measurement**, however precise, can distinguish a part of **phase space** smaller than the volume" (F. HEYLIGHEN, 1990b, p.479).

The indeterminacy relation, is frequently presented as the "**uncertainty principle**" (even by HEISENBERG himself!), which allows for metaphorical "psychologized" interpretations that should be carefully scrutinized.

K. BOULDING considers that "Physical systems in the small range, biological systems in the middle range, and **social systems** throughout their whole range are of ... probabilistic nature, and have... Heisenberg principle built right into them. ...For Heisenberg systems where **information** and the **observer** are of the same order of the **magnitude** of the system, and for the closely related probabilistic systems, the method of **general systems** is a necessity" (1964, p.35).

Recently, D. DUBOIS emitted the hypothesis that "As velocity is the temporal derivative of a particle's position, if the particle follows a **fractal**, i.e. broken, **trajectory**, it is impossible to know its precise velocity when well localized. The alternative should be considering **space-time** as of **fractal** nature, in which case it would not be **continuous**, but discrete" (1990, p.109).

In short, there is no easy way out of indeterminacy.

1634

INDETERMINACY RELATION: The Copenhagen Interpretation⁵⁾

F. SUPPE summarizes it as follows:

"Exploiting the fact that microscopic particles sometimes act like corpuscles and sometimes like waves, the HEISENBERG indeterminacy relation is interpreted as showing the impossibility of measuring a physical quantity without causing a **disturbance**. Any attempt to improve the **measurement** of a **parameter** which characterizes a system will have the inevitable result of disturbing the value of another **parameter** of the system: unlike the macroscopic **level**, on the microscopic **level** these **disturbances** will be non-negligible; thus it is impossible to find the position and velocity of a subatomic particle at one moment with complete accuracy" (1978, p.182).

Indeed, at the **macroscopic level**, velocity is measured by comparing two or more successive positions, which implies that in these cases measurement of position and velocity, while accurate, cannot be really **simultaneous**. The real difference with microscopic particles is that here the system's **identity** is not significantly affected.

1635

INDEX

→ **Semiotics**

1636

INDICATION^{2) - 3)}

"...a marking of the two distinguished **states** as being primary ("this", "I", "us", etc.)" (J.A. GOGUEN and F.J. VARELA, 1979, p.32).

These authors observe: "... indeed it is the very **purpose** of the **distinction** to create this indication" (Ibid).

The **purpose** is, of course, the **observer's** one. Thus, "an **observer** can make a **distinction** into an indication through the imposition of his **value**" and, "Conversely, the **distinctions** made reveal the cognitive capabilities of the **distinction**" (Ibid).

From another viewpoint: "It seems to be a general reflexion of the richness of natural systems that indication can be iterated to produce a **hierarchy of levels**" (p.33)

→ **Calculus of indications**

1637

INDIVIDUAL¹⁾⁴⁾

LUHMANN defines an individual (or person) as a "social identification of a complex of expectations oriented through a single man" (1984, p. 286), and a person is "a **structure** in the **auto-poiesis of social systems**" (1990, p. 33)

These quite abstract definitions show the very special position of the individual, who is in **structural coupling** simultaneously with his/her **environment**, with his/her society and him/her self.

These same characteristics can also be observed in animal societies (migratory locusts, termites, ants, bees, etc) But in these cases it would be very questionable to name individuals as persons, because of the scant development of their **brains**.

1638

INDIVIDUAL SPACE

→ **Proxemics**

1639

INDIVISIBILITY OF GLOBAL PROCESSES^{1) - 3)}

In his critique of the EINSTEIN, ROSEN and PODOLSKY paradox, N. BOHR "... argued that in the quantum domain the procedure by which we analyse classical systems into interacting **parts** breaks down, for whenever two entities combine to form a single system (even only for a limited period of **time**) the **process** by which they do is not divisible. We are therefore faced with a breakdown of our customary idea about the indefinite analysability of each **process** in various **parts**, located in different **regions** of **space** and **time**. Only in the classical limit,

where many quanta are involved, can the effects of this indivisibility be neglected" (D. BOHM, 1980, p.73).

Thus *indivisibility is another interesting formulation about the limits of reductionism*. It has also important implications for the dubious way we **dichotomize** our most basic **concepts** as **time**, **space**, **matter** and **energy**.

It can however be argued that the indivisibility problem may surge at *any complexity level*, and not merely at the quantum **level**. In all cases it is a result of multiple *simultaneous interactions* among numerous **elements**.

→ **3 bodies problem**

1640

INDUCER²⁾

A **process** which facilitates the needed **response**.

This term has been coined by R. ROSEN, who also uses the opposite one: **repressor**, and stated that, in a **network**, "... the **behavior** is always the outcome of an **interaction** of pairs of antagonistic activities, one of which excites a particular **response**, and the other of which inhibits it" (1974, p.171).

→ **Agonistics, Antagonism Principle**

1641

INDUCTION²⁾

1. The production by a **message** of a specific **reaction** in a receiving **element**.

Interactions seem to be inductive by their very nature. Nothing at all should happen if the receiving **element** would not be able to decipher the **signal**.

In biology, St. KAUFFMAN considers induction "as a basic intercellular conversation" (1993, p.540).

As the condition for deciphering **messages** must preexist, induction seems to depend somehow from **organizational closure**, or **autopoiesis**.

2. The obtention by reason of a general statement or **law** from repeated **observations**.

Or, in R. AXELROD's words: "Induction is the discovery of **patterns** in empirical **data**" (1997, p.17)

"For example, in the social sciences, induction is widely used in the analysis of opinion surveys and the macroeconomic **data**" (Ibid)

According to E.von GLASERSFELD: "... induction, whether it is conscious in the form of a conclusion we draw, or unconscious, in the form of a **behavior** that becomes established because of its success, springs always from the same root: a more or less regular recurrence in past experience" (1988, p.43).

On induction as a human mental faculty, POPPER proposed to construct an induction **machine** that "could by repetition "learn" or even "formulate", **laws** of succession which hold in its "world"... However he immediately

criticized his own argument, stating that: "In constructing an induction **machine** we, the architects of the **machine**, must decide *a priori* what constitutes its "world", what things are to be taken as similar or equal; and what kind of "laws" we wish the **machine** to be able to "discover" in its "world" (Quoted by L. LÖFGREN, 1993, p.104).

As observed in turn by LÖFGREN, quoting TARSKI and GÖDEL, this is still another case of the fact "that there is no **language** admitting a theory with its own **truth** predicate" (p.105).

This is coincidental with Ch.S. PEIRCE statement that "induction has its role not in the forming of hypotheses, but (in certain **fields**) in testing the hypotheses arrived at by abductive **inference**" (as quoted by P.R. MASANI, 1994, p. 45)

Abduction is thus the "prime mover", followed by induction as "the inference corresponding to the **habit**-forming aspect of the mind, and **deduction** is the inference corresponding to the volitional aspect of the mind (Ibid, p. 46)

In all three stages- but to begin with the abduction process- a pre-active involvement of the scientist mind (see the discussion of this term) is always present (Ibid, p. 47)

We may also observe that the "receiving **element**" of the definition could not decipher any **message** without counting with the adequate **code**, which comes to the same as POPPER's argument.

1642

INDUCTION (Principle of) ¹⁾³⁾

"The future will in certain respects resemble the past" (J. BRYANT, 1991, p. 150)

This means that induction, as a **meaning** creation **process**, implies a hidden **belief** in coherent and stable correspondances between some **observations**, stored **memories** and **reference frames**

BRYANT expresses this as follows: "...induction may be explained as the product of **neural linkage** between **engrams**, or, in psychological terms, as **associations** between ideas" (p. 117 and 150-51)

This is very different from the **deduction process** which in BRYANT terms "...is the act of making an engram generalization from the premises "or..." the process of deriving statements (called *deductive conclusions*) from some *fixed set* of statements (called *deductive premises*)" (Ibid)

Induction creates new combinations, that normally lead to modifications in **frames of references**

Deduction merely explicits already existing **implicit knowledge**

→ **Abduction**

1643

INDUSTRIAL DYNAMICS ^{2) - 5)}

A computer-based technique of **modelization** of complex business and industrial firms.

Industrial Dynamics was proposed by J. FORRESTER, of the M.I.T (1961), and later on extended to socio-economic and socio-ecological systems in general (See "**Club of Rome**", "**Systems Dynamics**").

The I.D. **models** are expressed in DYNAMO, a computer **simulation language**, also developed at M.I.T.

I.D. **modelization** is generally based on interconnected **feedbacks** between a number of **variables** considered to be basic for the **adaptation** and **evolution** of the system under study. It produces important insights into the **causes** and **effects** of **disturbances** in **processes**, their propagation, their more or less **cyclical** character and their final impact on the **stability** of the system.

However, the selection of the **variables** to be considered, the definitions about their **relationships** and the **reliability** of the collected **data** may all be controversial (Ch. FRANÇOIS, 1977).

Also J.van GIGCH observed (quoting I. ANSOFF & D.P. SLEVIN, 1968, p.395): "Industrial Dynamics has been criticized because it is not "a theory" in the sense of providing 1) "**predictions** about relations of **variables** which have not been previously observed" and 2) "a verification of **validity** of the theory through comparison of relations established in theory with observable relations in the real world" (1978, p.330).

FORRESTER himself rightly observes: "Like all **simulations**, the "**behavior**" of the system is dependent on the **structure** of the **model's** equations. As such "Industrial Dynamics" deals with **closed systems**. This means that the **behavior modes** of interest are generated within the **boundaries** of the desired system" (1961, p.406).

In synthesis, any result obtained is implicit within the **model** as it has been constructed, which however does not diminish the interest of revealing probably unsuspected **behavior modes**. I.D. models have a kind of **organizational closure**.

1644

INERTIA ¹⁾

Resistance to **change**.

Most systems possess their characteristic inertia, which can be physical, chemical, ecological, psychological, economical, or socio-cultural.

This property corresponds to the existence of **thresholds of stability** under which no decisive **change** can take place. Even simple **adaptation** is frequently met with long inertial resistance.

Inertia seems to correspond to the presence of **negative feedbacks** that are able to maintain **stability** as long as they count with **reserves** to compensate **deviations**.

Unheeded inertia can lead to a false appreciation of the **adaptation** possibilities of a system. Conversely, to believe uncritically in inertia, especially of **ecosystems** and **sociosystems**, may well induce a false belief in inherent **stability** of the same.

1645

INFERENCE ^{1) - 3) - 4)}

"The production of one or more beliefs or assumptions by one or more other beliefs or assumptions" (R.L. ACKOFF & F.E. EMERY, 1972, p.113)

But, to begin with, wherefrom came the first beliefs or assumptions? Cultural nurturing seems to play an important role in the ways "... **signs** denote what they do on the three principles of resemblance, **contiguity** and **causality**" (C.S. PEIRCE, in 1991, p.80).

In any case, the **recursive** definition given by ACKOFF and EMERY is justified as follows by these authors: "... there is a **set** of beliefs and assumptions that the **subject** is willing initially to accept as true. These beliefs and assumptions contain only **elements** of the system and are expressible consistently with the formation **rules**. These **rules** constitutes the *premises* of the system. In a deductive system these premises may be axioms or postulates; in an inductive system they may be a **set** of accepted **facts** or **observations**" (Ibid).

This implies an important caveat for any systems **modelization**: Inference is related to **habit** formation and **habit** formation leads to uncritical attitudes.

1646

INFERENCE RULE ⁵⁾

"A rule that produces new **facts** on the basis of older ones" (E. BUCHBERGER, 1987, p.49).

Such rules are a basic feature of **expert systems**.

E. BUCHBERGER adds: "This results either from strong logic principles, or from incomplete, **heuristic** methods (inductive or deductive inferences)" (Ibid).

(Let us remember that "**facts**" are *constructed* by the **observer**).

1647

INFLECTION POINT ^{1) - 5)}

In mathematics, the point of a curve where the tangent crosses it.

The **logistic** curve, for example, has an inflection point where the acceleration factor becomes dominated by the braking one, i.e. where the **positive feedback** becomes slowed down by a **negative** one.

Inflection points are very important to observe because they signal a basic change of the **trend**.

1648

INFLEXIBILITY^{1) - 2)}

The condition of a system which loses its capacity of **adaptation or accomodation**.

As explained by C. HOLLING, there is always a trade-off between **stability** and **instability** in systems. **Dynamic stability** is an advantageous and economic state of affairs as long as its basic **environmental** conditions are maintained. When such conditions persist for a very long time, the system is however at risk to "forget" possible **responses** to strong and infrequent **perturbations**.

HOLLING suggests that the **optimum** for any system is to possess alternative states of **dynamic stability** (or **domains of attraction**), through which it may switch when necessary. He gives numerous ecological examples of **flexibility** in **populations of living systems** which are endowed with this type of **flexibility**. (1976, 1986).

1649

INFOLDING²⁾

The **emergence** of a new **level of complexity** *within* a system undergoing a **process of dissipative structuration**.

This term has been proposed by C. JOSLYN, who writes: "We usually think about **emergent phenomena** as entering at the "pinnacle" of some **evolutionary hierarchy**. In contrast, we regard this kind of **emergence** not as adding a **layer** on top of a **hierarchy**, but rather as a "deepening" of "in-folding" of an existent **hierarchy**. The new **level** is added between what was previously (and still is) the bottom and the top **levels**" (1991, p.639).

For example, the **emergence** of a highly developed neo-cortex in the human **brain** is a result of internal differentiation of an existing **structure**. This example however seems to indicate that such an "in-folding" may lead in some cases to the **emergence** of a new and **higher level of complexity** in a different sense: **numerous** individuals endowed with these evolved **brains** are able to create social **organization** on a new innovative **level**.

1650

INFON¹⁾³⁾

"A postulated general **information** particle". S. BRIER, in his review of T. TONER's book on "Information and **Meaning**" discussed the proposed new term (1998, p. 82)

He writes: "The Infon is defined very much along the lines of how originally in the sciences the conceptualization of human work has reduced to form the general concept of **energy** in nature".

Reflecting on the progressive use, extension and deepening concept of energy, for comparison, BRIER observes that this was a productive, but quite strenuous **process** because it took place within the **mechanistic framework** of 19th Century science. He adds similar comments about the difficult progress of Planck's quantum during the 20th Century.

It is clear that the different forms of **information transmission** (**languages**, the semiochemicals (another neologism!) electronic devices have a basic common feature...whose deeper meaning could probably need many more years to be better understood.

For now BRIER is questioning "the fruitfulness of the objective informational approach to give us a **framework** that can solve our problems of **understanding evolution**, intelligence, **consciousness**, **man-machine** interface and cooperation, plus the enlightenment of our understanding of signification and **information** processing in general" (p.85)

1651

INFORMATICS⁵⁾

Everything that has to do with **information** processing by **digital** computers.

This term is used mainly in Europe and in Latin America ("Informática")

K. KRIPPENDORFF writes that Informatics "includes (the largely U.S.) **computer science**, the more application oriented efforts of **management information** systems, **automation** of production but also **data processing** including statistics for **decision making**".

He adds: "Because of its technological commitments, informatics has desensitized the study of **information flows** and computation within **organisms** and largely ignored the organizational consequences of **information flows**, **human communication** and the use of computers in large **social systems**" (1986, p.38).

1652

IN - FORMATION¹⁾

Progressive internal **structuration** of a system.

This should be taken as a systemic etymological exploration of **meanings**!

Any **complex system** seems to start with a basic **program**, or **grammar** of **rules** which endows it with its proper, unique and permanent **identity** (**organizational closure**) However, internal **structuration** results of a progressive build-up, through the **interaction** of the **program** with the basic or circumstantial **environment**.

This is specially true of man as thus expressed by L. THAYER: "...all other creatures enter the world essentially *pre-formed* to take into account that which they can and must. Not

so, man. He must be *in-formed*, and this, by his fellows. What is therefore real, important, relevant, etc., for man must be learned by him (or "taught" to him). A common cricket is merely **informed** by certain **signals** which he has been **pre-formed** to receive and respond to. A man is both informed and *in-formed*. Because he has received and acted upon it once, no "**message**" will ever be exactly the same to him again. A man evolves as a human out of his **communication** experiences. He is irreversibly altered" (1972, p.105-6).

1653

INFORMATION^{1) - 3)}

1) "The **content** of a **message** apt to trigger some **action**" (J.de ROSNAY, 1975, p.168).

In this view, as stated by W.R. WINBURN, "information is "the **difference** that makes a **difference**" (1991, p.558).

The definition given by J.de ROSNAY is a most general, and pragmatic one.

It opens however some intriguing questions, as shown by the following example: A sculptor starts his/her work on some block of stone. The "information" is what she or he has in mind (let us not here inquire wherefrom it came!). The work progresses through the sculptor "**message**" to the stone, by hewing slowly some face or figure out of it. The **message** is transmitted through the nervous and muscular system of the sculptor and the chisels.

The "**receiver**" is the stone, but it is quite a passive, not an active one. Such is the mystery of the creative act. It is kind of a **message** of the creator to some passive material, which thereafter acquire a power, becomes a bearer of information as the creator communicates with him or herself and to others through the "informed" material, which is now "informative".

On the other hand, **many receivers** can be directly activated by a **message** (see for example "**selective content of information**").

In J.de ROSNAY words: "Aristotle introduces an important **distinction** between both **meanings** of the word information. On the one hand, information is understood as "acquisition of **knowledge**" (it is the act to inform oneself by observing some **object** or nature). On the other hand, information means "power of **organization**" or "creative **action**" (p.168).

2) A more or less organized **set of data** transmitted from one intelligent system to another.

Information, sometimes confused with its **communication**, is not merely basic to systemic **methodology**, but altogether a central and many-sided systemic **concept**.

1- Information exists within informed systems, i.e. organized entities able to translate some basic **data** into coherent **action**.

2- Information has a specific human **meaning**.
 3- Information "is descriptive: it is contained in answers to questions that begin with such words as What, Which, Who, How many, When and Where" (J. GHARAJEDAGHI, 1985)

4- It has moreover a **semantic meaning** (Mac KAY's "**logon**"), different from its quantitative measure.

5- However, information can also be measured and, in this quantitative sense used to dispel some degree of **uncertainty**.

→ "**Entropy versus Improbability**".

6- It can be related to the increase or local decrease of **entropy** production, i.e. tipify degrees of systemic **organization**.

The concept of information has been quite enriched, but, alas, also muddled as a result of the development of computer science (**informatics**).

Confusion started when C. SHANNON published his "**Theory of Communication**", which nearly everybody calls erroneously, a "Theory of Information". As an electrical engineer working for a telephone company, his basic purpose was to investigate the *communication* of information through a **channel**, namely at the time telephone wiring.

On this specific aspect Mac KAY writes: "A further question was where, if anywhere, the notion of "**meaning**" fitted into the scheme of things. SHANNON's analysis of the "**amount of information**" in a **signal**, which disclaimed explicitly any concern with its **meaning**, was widely misinterpreted to imply that the engineers had defined a *concept* of information per se that was totally divorced from that of **meaning**" (1969, p.5).

As to what information really means, we may quote T.S. Eliot who asked somewhere: "Where is the **knowledge** we lost with information? Where is the wisdom we lost with **knowledge**?" Possibly, some deciders would add: "Where is the information we lost with **data**?" Indeed, during the last 40 years the technology of information **transmission** and treatment has seriously obscured the problem of **meaning**, in its different guises.

Data cannot be transformed into information by *themselves*. Whatever is offered by a newspaper, a radio or a T.V. set, or a computer, is merely raw material, which acquires significance only when integrated within a **frame of reference**. Thus, only a modicum of previous **knowledge**, offering such a frame can transform **data** into information. In turn, this information may then transform or expand pre-existing **knowledge**, for example through a Popperian process of falseation (for which **meta-rules** are needed). Finally, the proper uses of

well-informed **knowledge** is ELIOT's wisdom, as a **meta-frame of reference**.

A massive flood of **data**, even ordered in some base, merely overwhelms the best minds if not organized within a well defined **frame of reference** and sustained by clearly stated **purposes**.

Using adequate physical and semantic **codes**, we communicate our **observations** and our interpretations to other people, in order to:

- confirm, correct or invalidate what we did register or conclude;
- obtain **feedback** in order to complement our own results;
- seek a **consensus** leading to common **understanding** and collective **action**;

Only after such constantly renewed exchange, we may speak of "information" referring us to confirmed and circulating **meanings** admitted by some specific **group** of people. Moreover, information becomes **knowledge** only when organized within a net of interconnected **meanings** whose **coherence** is generally recognized after due testing and **confirmation** by numerous people and during a long span of **time**. This is the **social frame of reference**.

As a still tentative synthesis, "information" is a many-sided concept, conveying by natural or artificial means collective **sets** of quite various **representations** acquired by **consensus** within specific **groups** of people.

It necessarily implies a **network** of interactive **elements**, whose **interactions** first *create* **rules** and thereafter *obey* them. This supposes **change**, i.e. a **space-time flow**. Such an **understanding** is less psychologically oriented, while still, unavoidably anthropocentric.

As such, the concept can be used in many different ways, if we keep in mind that its value is relative and that we must define clearly, in every case, what **frame of reference** we are using.

3) "That which adds to a **representation**" (Mac KAY, 1969, p.163).

Mac KAY comments: "...this leaves open the possibility that the information may be true or false. When a **representation** alters, we define the new information as true if the **change** increases the extent of correspondence between the **representation** and the original.

"The information is said to be false if the **change** diminishes the extent of this correspondence. Strictly, the **truth** or falsehood is an attribute of the resultant **representation**, but it is customary to attribute it to that which has given rise to the **change** in the **representation**" (p.163).

4) "...that which does logical work on the **organism's** orientation (Mac KAY, 1969, p.96).

Mac KAY adds in this case: "(Whether correctly or not, and whether by adding to, replacing or confirming the functional **linkages** of the orienting system)" and "...Thus we leave open the question whether the information is true or false, corrective or confirmatory, and so on" (Ibid).

5) "A measure of **selection** among a given **set** of possibilities" and also "Sometimes a measure of the extent to which **uncertainty** is reduced" (G. PASK, 1961, p.115).

"A **message** that produces a **change** in any of the **receiver's** probabilities of **choice**" (Adapted from R.L. ACKOFF & F.E. EMERY, 1972, p.144).

These last authors state: "Because of the pervasiveness of the use of information in the restricted (technical) sense of SHANNON's information theory (SHANNON and WEAVER, 1949), it might seem preferable to use another term here. But since the way that we use information here conforms more closely to common usage than does SHANNON's, if a change is required it would seem preferable to change SHANNON's term". Let us remember that that part of SHANNON's theory is of quantitative nature" (Ibid).

The same authors quote C. CHERRY who wrote: "In a sense, it is a pity that the mathematical concepts stemming from HARTLEY have been called "information" at all. The formula for H_n is really a measure of one facet only of the concept of information; it is the statistical rarity or "surprise **value**" of a source of **signs**" (1957, p.50).

A. RAPOPORT states: "The **concept** of information is as central in **cybernetics** and **communication** engineering as the concept of **energy** is in classical physics.

"**Energy** has been the unifying concept underlying all physical **phenomena** involving work and heat. Information became the unifying concept underlying the working of organized systems, i.e. systems whose **behavior** was under **control** so as to achieve some pre-set **goals**" (1966, p.5).

As may be appreciated, this very fundamental aspect is merely implicit in PASK's and EMERY and ACKOFF's definitions.

P.S. HENSHAW explains: "Information is an entity apart from the means by which it is processed, the **symbols** by which it is represented, or the **responses** made to it. **Messages** contain intelligence (dispositional, organized, usable and available information), but as such do not themselves constitute intelligence.

"Information can be transmitted and stored by means of impulses and **symbols**, but it exerts an influence only after removal from the encoded **message** and **interaction** with other information, as can happen in a **cell**, a **brain** or a computer...

"Information as such is not amenable to quantification in a manner comparable with that which applies to entities having force, mass and charge.

"In the last analysis, information consists of **data**, especially unrelated **facts** and statistics. With **organization of data**, intelligence is created and with further **organization** of organized **data**, intelligence is developed and advanced" (1975, p.18).

It seems that HENSHAW uses the term "intelligence" in the sense of "**understanding**".

Moreover, information "... can be created and destroyed" (p.18). This is also ambiguous. What can be destroyed are raw **data**, or organized **sets of data**, or the results of the treatment of **data**, or even some forms of **understanding** of these results.

In effect some original **rules of organization of perceptions** are needed in order to obtain **organization of data**, and that both kind of **organization** must become constructed as properties of a progressively self-constructed **network**.

1654

INFORMATION (Amount of) ⁵⁾

"A logarithmic measure of the statistical unexpectedness (reciprocal of probability) of the **message** concerned" (D. Mac KAY 1969, p.79).

Mac KAY states: "Since the unexpectedness of a **message** need not have direct **connection** with its **semantic content** or **meaning**, SHANNON wisely insisted that the concept of "**meaning**" was outside the scope of his theory" (Ibid).

Basically and inasmuch as SHANNON's work is related to information, it should be definitely understood that it is about quantitative information and its **measurement**.

"As an example let us suppose that we must select one object out of a collection, on the base of a specified criterion: for example the letter O within the alphabet. The most economical method is to divide the alphabet in two and ask: is O in the first half or in the second one? The answer provides us with one **bit** of information, corresponding to the fact that O is in the second half. Following in the same way, we now divide this second half in two and repeat our question. The answer: "O is in the first half of the second half" provides us with a second **bit** of information. Finally, we will find out that the number of **bits** we need to "place" O in the alphabet, is the logarithm base 2 of 26, i.e. 5 when rounded off to the next whole number of **bits**, taking in account that **bits** are necessarily whole numbers" (Ibid.).

This is in accordance with SHANNON and WEAVER, who consider the amount of information as a basically technical feature, which: "... characterizes the whole statistical nature of the information, and is not concerned with individual **messages**" (1949, p.104).

In this quantitative sense, information is thus defined as the logarithm to the base 2 of the possible combinations C, i.e.: $I = \log_2 C$. As logarithms are exponents, quantitative information is an **additive** measure of **complexity**.

Obviously, apart from the quantitative aspect of information, as expressed for example in **bits**, the qualitative aspect is quite a different matter, as it relates to **meanings**, which "make sense" only in exchanges between sentient and thinking beings, and not, for example, for the telephone sets themselves.

1655

INFORMATION and INFORMATION-CONTENT ^{1) - 5)}

D. Mac KAY states that a problem arises when information is confused with information content, i.e. "the confusion of a thing with a measure of a thing" (1969, p.56).

In his opinion: "**Communication** engineers have not developed a concept of information at all. They have developed a theory dealing explicitly with only one particular feature or aspect of **messages** "carrying" information - their unexpectedness or surprise value. Unexpectedness is a feature not only of **messages** but of other things, such as the **states** of a physical system. Physicists had already developed a quantitative method of measuring unexpectedness: by BOLTZMANN's statistical concept of **entropy**. What SHANNON and others did was to adopt and extend this method to the **measurement** of the unexpectedness of **messages**.

"Their measure of unexpectedness, the average logarithm of the improbability of the **message**, $-\delta p_1 \log p_1$, is not therefore information, but simply a particular measure of what they termed amount-of-information; (i.e.) the minuteness of the **selection** which the **message** makes from the **set...** of all possible **messages**".

"In this **set**, the different possible **messages** are pictured as occupying a space proportional to their relative probabilities, as that the least probable **message** occupies the smallest space and requires the most minute selective **operation**" (p.57).

1656

INFORMATION, as an energy modulation ¹⁾

It is sometimes forgotten that no information can be transmitted without an **energy** support of some kind. Moreover, this **energy** must be modulated, i.e. its **transmission** must be irregular, have some **rhythmic complexity** in form of a mix of **waves**. Thus the **energy-information dichotomy** is, in some sense a mental fabrication, becomes easily a quagmire, and should be used with care. In R.N. ADAMS words: "Information succeeds in stimulating, igniting, moving and more generally triggering

energetic **activity** because, and only because, it is also energetic **activity**... The insistence on dualism has inhibited exploring how the two were related" (1988, p.80).

In this sense, the insistence of BATESON on information as consisting only of abstract "**differences**" may lead to epistemological problems.

All that we have learnt about the different forms of **energy** confirms that it presents always a **variety of frequencies** and **amplitudes**. On the other hand, physical sciences and technology showed that such **frequencies** and **amplitudes** may be, or not, perceived by various natural organic **receptors**, which became adapted in a selective way to only some of them.

Moreover, present technology allows artificial **decoding of frequencies** and **amplitudes** that cannot be perceived organically, and their conversion into perceptible ones. In this way we succeed in transforming potential information into usable one. Such is the case with ultra and infrasounds, radio waves, ultra-violet and infra-red radiation, X-rays, gamma-rays, etc...

In all these cases, there is no doubt that information is carried along by energy. However, the origin of modulations and of our ability to perceive only some of them is still not so clear.

1657

INFORMATION COMPRESSION ^{2) - 3)}

J. S. WICKEN writes: "Basic to the definition of order is informational compressibility" (1979, p.139).

Unless we find a way to condensate the information **content** of a system, the only **model** of it is itself, which means that our rational **understanding** of it is nil.

WICKEN explains: "Two modes of information compression are possible. One is **algorithmic**. This applies to cases in which patterned **relationships** appear in a sequence that allows **element-by-element** specification to be replaced by a **program** of instructions for its assembly" (WICKEN adopts thus G. CHAITIN's concept of **algorithmic compression** of information, also known as KOLMOGOROV-CHAITIN **complexity**) (1975, p.47-52).

"For example, the sequence (1,2,3,4) possesses a higher degree of **order** than does the sequence (1,3,2,4) because a briefer **algorithm** is required to generate it.

"The second is probabilistic, and the compression is measured by the relative **values** of real **complexity** and maximum conceivable **complexity**. This **mode** of compression applies to stochastic **processes** in which (a) the **symbols** are not equiprobable and/or (b) the occurrence of one **symbol** in a sequence influences the probability of occurrence of other **symbols**" (p.139).

1658

INFORMATION: CONTEMPORARY MEANINGS¹⁾ - 3)

According to A. ZELEZNIKAR: "Today's **meaning** of information concerns **communication** or reception of **knowledge**, or intelligence. But information is also **knowledge** obtained from investigation, study or instruction, as well as **data** and facts.

"At least, it is becoming clear (that)...the contemporary **meaning** of information is developing as **form** and **process** in the entire **phenomenology** and how this **meaning** will still come into existence during new investigations" (1988, p.187).

One of the main features of information as we understand it nowadays is that the same observed **form** may imply different **meanings** for different **observers**, but also that different information may lead to the same **understanding** to one **observer**, or to various ones.

Some **meanings** given to "information" nowadays seem over-extended.

Has for example the so-called genetic "**code**" an information **content**? Does it transmit "information", or "**data**" to the **cells**? Or is it information only for the micro-biologist and the physician?

Another difficulty surges from a frequent confusion between information and **communication**. Many times Cl. SHANNON and W. WEAVER's "Theory of **communication**" is referred to as "Theory of information", while these authors limit themselves to a study of a **channel's** quantitative capacity to transmit **data**, the needed (quantitative) **redundancy** to compensate **noise**, and the number of **bits** needed to discriminate **elements** of information. There is nothing therein about **meanings** in a **semio-logic** or **semantic** sense.

G.R. JOHNSON denounces some abusive uses of "information" in social sciences: "Social scientists are usually interested in the content of a **communication**, not just in the number of **bits** that it takes to encode (it)... (Most of them) use the term "information" to mean something roughly equivalent to "ideas, beliefs, attitudes, **values**, and other nonmaterial stuff". Unfortunately, they often seem to confuse the two different uses of this single term. Impressed by the rigorous measurement of "information" as defined by **communications** engineers and **computer scientists**, a great many social scientists have deceived themselves into thinking that their own imprecise, ordinary **language** concept of "information" has been given scientific legitimacy. It has not..." (1992, p.1147).

(See ZELEZNIKAR's essay for many stimulating insights on information and its actual derivations as for example: "informative", "**informatics**", "informatizable", "informatization", "informational **processes**" and the relations of these **concepts** with neurology, **brain**, **behavior** and the **observer's** problem).

1659

INFORMATION COST¹⁾

As information always needs an energetic support, it is never free. It is however much cheaper to move information through **energy** pulses than to use **matter** as a carrier or a store. This fact is becoming very relevant for **human systems**.

1660

INFORMATION (Degradation of)^{1) - 2)}

J.de ROSNAY discusses in the following way the progressive degradation of information: "Information which circulates in a **channel** becomes irreversibly degraded. This implies a very significant **analogy** with **energy**, which degrades... through **entropy**. For example if we make a mold of some statue and cast from this mold another statue from which we make another mold, it is highly probable that after a score of successive operations of this kind, the final **form** of the statue will be highly distorted...

"To transmit information, **energy** must be spent. This energetic medium for information consists of light rays, sound waves, electric current in a telephone wire or the flight of the bee which transport pollen from one flower to another. This **energy** becomes weaker and scatters. It must be canalized and amplified. Moreover as the precision of some **measurement** needs to be greater, more **energy** must be spent" (1975, p. 169-170).

Thus is introduced the **interrelation** between **entropy** and information, both of which evolve in the **time** dimension.

→ ("**Information half-life**).

1661

INFORMATION (Distributed)²⁾

A situation in which information is carried by numerous **elements** of the system in a more or less redundant manner.

R. MARGALEF states: "Information ... is a property of everything that is formed of different **parts**" (1980, p.19).

Distributed information in **brain**, computers or natural or artificial social **networks** allow for better chances of **survival** of the system if part of the **network** is impaired. It is one of the basic characteristics of **heterarchical organization** and **loosely coupled systems**.

1662

INFORMATION DYNAMICS¹⁾

P.S. HENSHAW, after observing that: "**Self-organizing systems** are **energy**-information **input-processor-output** units, living or non-living, that are **adaptive**, **purposive** and discretionary", thus describes the basic features of information dynamics:

"1. Information seeks **consistency** ... in systems that have capacities for **memory**, **assimilation**, **integration**, and selective **energy distribution**, including **switching**, channeling and gating.

"2. Information interacting with information is generative...

"3. ...Accepting that information seeks **consistency**, it follows that consonance is a **goal** of information **processing**.

"4. Dissonance irritates, motivates, activates. It can lead toward consonance, or toward greater dissonance, involving antagonisms, aggression, **chaos** and destruction.

"5. Curiosity - the desire to know - is inherent in **assimilation**. Because information seeks **consistency**, mentation involves a continuous search for new information.

"6. The human mind... is inventive. It will create - even fabricate - **images**, explanations and **concepts**..." (1981, p.16).

HENSHAW also states that: "Information, like **energy**, exerts an influence" (p.17). However, while interesting, these ideas are somehow giving to "information" the character of a human actor.

1663

INFORMATION (Entropy and)¹⁾

As noted by S. UMPLEBY: "Information and thermodynamic entropy are different concepts. Only the equations are similar".

However, information and **entropy** are somehow in a polar **relationship**. A. RAPOPORT, for example, writes: "WIENER's insight into the meaning of the mathematical connection between **entropy** and information provides further clarification of the fundamental principles of the living **process**. Increase of **entropy** can be viewed as "destruction of information". Conversely information can be used to reduce **entropy**" (1966, p.6).

J.de ROSNAY explains in these words the antinomic relation between information and **entropy**: "Any information which results from an **observation**, a **measurement** or an experience, and says what we already know, does not produce any **change** in the number of possible answers. It does not reduce our **uncertainty**. The information provided by a **message** or an **event** is so much the greater that its probability of occurrence was small. The information obtained by sorting *on the first draw* the

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

correct answer (for example $I=32/1$, in the case of a pack of cards) is the inverse of the probability to obtain it as it was before receiving the **message** ($I=1/32$).

"Now, probability and **entropy** are connected by statistical theory.

"One notices by comparing the different mathematical relations, that information is the opposite of the physicist **entropy**. It is equivalent to an anti-**entropy**. This is why the term **negentropy** (which means negative **entropy**) has been coined, in order to emphasize this important property. Information and **negentropy** are thus equivalent to potential **energy**" (which may be used to produce or transmit information).

"However this comparison may be furthered. By conveniently selecting the constant and the unities, it becomes possible to express information by means of thermodynamical units, thus connecting it directly to **entropy**. In this way it is possible to calculate the smallest "fail" of **energy** associated to some measure capable to generate a **bit** of information: in order to obtain an information equal to a **bit**, a very small, but finite, and thus significant, quantity of the universe's **energy** must be degraded.

"This very important discovery led some physicists, like L. BRILLOUIN, to generalize in this way CARNOT's principle, in order to express the undissociable relation between information acquired by the **brain** and the **entropy** variation of the universe: Any acquisition of **knowledge**, obtained from an **observation** or a physical **measurement**, uses up **energy** from the laboratory, and thus from the universe" (1975, p.171-2).

This also true for information obtained by a **receiver** through some **channel**, which could transmit nothing without using **energy**.

1664

INFORMATION: Etymological clarification ^{1) - 3)}

Etymology is quite an interesting platform when we explore the meaning of "information".

A. ZELENKAR writes: "Form is the essential root in grasping the **meaning** of information...

"...the Greek "morfe" means **form**, shape, figure, body, grace, beauty... the latin "forma (-ae,f.) is figure, form, appearance (exterior), beauty, picture, **sign**, plan, base, contour, manner, way, kind, quality. The latin "formatio (-onis,f.)" is creation, formation, **representation** (**mapping**). The latin verb "formare" has the **meanings** to form, shape, picture, represent; to educate, instruct, teach; to control, settle, adjust, **regulate**, put in **order**, make do, create, produce, execute. The latin prefix "in" has spatial, temporal, and modal **meanings**. They are: about, after, against, as, at, behind, beyond, during, in, into, on, till, to, towards, until, up to, upon, within, etc.

"In grasping the notion of information one has to consider the Latin word "informatio", which is the composite of "in", "forma" and "tio". Here, the **meanings** of "in" and "forma", with all their diversities and combinations, have to be taken in account. **Meanings** of the Latin informatio are forming, putting into **form**, presentation, notion, description of notion, explanation, interpretation, etc... In scholasticism, this **meaning** is etymological and ontological: it represents shaping of **matter** by **form**, where shaping is thought as a **process** itself and as a result. It has the **meaning** of forming the mind as a consequence of a co-natural **object** of **cognition**. Later, DESCARTES introduced the **meaning** of forming the **consciousness** by the physical **structure** of **brain**, which is becoming evident as **perception**" (1988, p.187).

To inform should also mean, in some cases "put **form** into something". Sir d'Arcy W. THOMPSON wrote many years ago (1916) a marvelous book about "Growth and Form", in which extended studies of comparative **forms** in plants and animals lead the reader to the insight of the existence of what we could call "meta-forms". For us, humans, there is a rich information to be extracted of "nature's play with families of forms". But, of course, we are again lending significance and human motives to an abstract and projected entity invented by our brains: "Nature".

Even so, we are able to perceive numerous **forms**, to coordinate many of them in families and to extract from them a quite general **information**.

1665

INFORMATION (Evolution of) ¹⁾

S. GOONATILAKE proposed an evolutive hypothesis about information: "The **evolution** of information on earth gave rise to the sequence of information cores which emerged corresponding to these different environmental stages. In the first core, the struggles with the **environment** is coded in DNA. Later, outer flow cores are 'externalized' from this inner core of DNA, corresponding to the cultural **flow** lines running through **brains**. Still later, **exosomatic** information **flow** lines are externalized out from the biological package" (1991, p.132).

Moreover: "The different **flow** line cores do not exist unconnected and unattached to each other. They are inexorably linked... It is a continuing **process**, of reacting with and adapting to the **environment**. The tendency towards further elaboration and **evolution** of information is therefore but a necessary outcome of an almost inevitable phylogenetic **process**" (ibid).

The successive and progressive **forms** of information are thus embedded within each other. Curiously, this **process** seems to be accelerating through time, which parallels F. MEYER's theory of **evolutive acceleration**.

1666

INFORMATION (Generative) ^{1) - 2) - 3)}

A basic information **set** which is able to generate a specific type of **order** in a quite wider **space-time**.

The genetic **code** may be considered an example, and in a different setting, the **values** system of a **community** or culture. The concept is closely linked to D. BOHM and F.D. PEAT's "Generative order" (1987, p.195).

1667

INFORMATION (Irrelevant) ²⁾

"Information which operates on a subspace orthogonal to that specified by the question" (D. Mac KAY, 1969, p.74).

This somewhat abstract formulation means that any question specifies an area in which information is needed and any information not referred to that area has no practical value as a **response** to the question.

Mac KAY adds that irrelevant information "is clearly distinct from "semantic noise" which is any feature of a **message** that reduces the sharpness of the selective **operation** on the required subspace" (ibid) (i.e. within the specified area).

1668

INFORMATION (Positional) ^{1) - 5)}

Morphogenetic information potentially present in the specific spatial **interrelations** of some **elements** in an incipient system.

This notion emerged in the 1970s (L. WOLPERT) in the study of genetically based differentiation in living beings **organization**. Such differentiation corresponds to chemical **gradients**.

The relative positions of some genes (homeobox genes) "allows one **part** of the embryo to be labelled as different from all other **parts**... Such information is present even in the unfertilized egg **cell**... (where) there is already a "head" end and a "tail" end.

"The amount of positional information builds up during the development of the embryo. Eventually the positional information is so complex that very small groups of **cells**, destined to become a particular **part** of the body, can be distinguished" (S. DAY, 1990, p.4).

More generally, positional information is related to **symmetry-breaking**. G. NICOLIS and I. PRIGOGINE state: "Physiologically, the best known type of positional information is ensured by monotonic **gradients** of appropriate **morphogens** establishing a polarity within the **field**... A **gradient** (or more generally a primary spatial **pattern**) arising in this way should have some well defined reproducibility" (1978, p.26).

The notion of positional information looks like a good candidate as a general systemic concept; for the following reasons:

- it seems to be related to a universal concept of polarity
- it seems to be a bridge between **levels of autopoiesis**
- it connects both **meanings** of the concept of **morphogenesis**
- it makes sense in practically each **level of complexity** from crystals to human societies (**stigmergy**).

1669

INFORMATION (Potential)¹⁾⁽³⁾

As noted by D. GERNERT, information may exist in a potential form (or structural **form**) as for example in a crystal (2000, p. 255)

The use of two different terms – structural, potential- is very useful; for a better understanding of the nature of information.

A crystal is an ordered **structure**, would we say. But to say it in that way implies a **semantic ambiguity**. In fact the structure becomes apparent only to somebody who is able:

- 1) to observe it by sight or using an appropriate device
- 2) to make sense of what can be seen "Potential" information becomes effective only after passing through **perception** first, and interpretation next.

This becomes still clearer when we find out that deformations in our perception and spurious interpretation (i.e. that does not allow us to act efficiently on the base of our view) can lead us completely astray-even if structural information has not changed, i.e. is still there potentially within the crystal.

1670

INFORMATION (Pragmatic)¹⁾⁽³⁾

The impact of transmitted information upon the receiving system (Adapted from D. GERNERT, 2000, p. 254)

GERNERT adds "Information is anything that alters the **state** or the **behavior** of the receiving system"(Ibid)

It should be noted that information acquires **meaning** only when the **receiver** is a living being, specially a human being who is capable of very elaborate **understanding**, interpretation and subsequent **action**.

A barometer, for example, registers **changes** in atmospheric pressure. But it has a graduated face, because it can have a practical use only if a person is able to register a reading in a way that makes sense for he/she.

1671

INFORMATION (Quantitative)⁵⁾

"The minimum... number of **binary** steps by which the **representation** concerned may be selected from an ensemble of possible **representations**" (D. Mac KAY, 1969, p.80, as stated by SHANNON).

This minimum number is the $\log_2$ of the number of **representations** or **objects** included in the **set**.

Or the number of **bits** which is necessary and sufficient to diminish, up to some degree, or to totally suppress any **uncertainty** in the **knowledge** of some situation or system. See: "**Information (Amount of)**".

This is why it is sometimes expressed in terms of "**negative entropy**".

1672

INFORMATION (Selective content of)¹⁾

"A measure of the unforeseeableness of a **representation**" (D. Mac KAY, 1969, p.176).

Mac KAY states: "This is a relative measure, depending on the number of distinct results which are regarded as equally probable by the **observer**."

"The result observed is thought of as specifying one of a number of possibilities already contemplated by the **observer** as forming an ensemble in defined proportions" (p.174).

By "ensemble" Mac KAY means: "A **set** of possibilities, each of which has a defined probability" (p.175).

The concept is close to VENDRYES' one of "subjective probability": Probable (more or less so) is any **event** which did not yet occurred (or, from a different viewpoint, has not yet been observed).

Mac KAY still adds: "Selective information-**content** in fact measures not a stuff but a **relation**, and is not defined unless both terminals of the relation are specified" (p.77). See "Formation of **meanings**".

In a slightly different meaning, information is selective as it carries "**difference, distinction, order, constraint, pattern, etc...**" (G. ANDERSEN, 1995).

G. BATESON made a similar point when defining information as "Any difference that makes a difference" (1979, p.228)

1673

INFORMATION (Shared) in multiple agents systems^{1) - 5)}

J. ERCEAU and J. FERBER, who are researching **multiple agents systems** (wherein **communication** is paramount), write: "There exists presently two types of architecture for **communication** systems (i.e. in M.A.S.). One instates a **communication** procedure by shared information, and concerns basically advanced **agents**, namely cognitive ones. This procedure uses a common space (the "**black-board**"), centrally controlled on which every **agent** writes or reads informations. The other, used indifferently by cognitive or reactive **agents**, consists merely in exchanges of asynchronic and **discontinuous messages** from one agent to any other" (1991, p.754-5).

Such devices curiously mimic centralized or decentralized social **communications** systems.

1674

INFORMATION FLOWS²⁾

As noted by E. LASZLO: "Information flows through the system and connects the various **components** according to definite functional **patterns**. Each **component** receives information, processes it according to the tasks assigned to it, and produces more information which in turn is received by one or several other **components**" (1974, p.152).

The correct plotting of information flows in the system is one of the basic features of J. FORRESTER's **Systems Dynamics**. In a more general sense, any kind of **network** is closely depending on information flows.

Graphs are practical tools to trace and visualize information flows.

1675

INFORMATION FROM CONTEXT¹⁾⁽²⁾⁽³⁾

In the widest sense, we obtain all information from our **environment**, through our **interactions** with it. But the quantity of information that we are able to gather depends on our own mental (and psycho-motor) **frame of reference**. For example, a geologist observing a rocky mountain cliff would gather more information from some of the features he sees than a common **observer**, because he knows the implicit **meaning** of the sedimentary strata he observes. He thus becomes able to interpret what he sees and even register some specific and peculiar characteristics out of which he may develop a deeper **understanding**.

The point is neatly made by I. STEWART in a paper about magic. The magician is basically a trickster who uses **codings** and **rules**. specially if working with an aide. He becomes able to gather information from gestures or words that seem indifferent to spectators (2003, p. 38-39

→ **Code; Experimental frame; Frame of reference; Meaning (Formation of); Meaning theory; Observation process; Observer**

1676

INFORMATION HALF-LIFE^{1) - 4)}

"... the amount of **time** for half of the given informational **set** presently serving as a base for tying a society successfully to its **environment** to become useless" (T.R. YOUNG & G. SWARTZMAN, 1974, p.260).

The authors who introduced this somewhat metaphorical concept, (obviously by **analogy** with half-life of radioactive compounds) used it to construct the following "general principle of irreversible sociothermodynamics:... The short-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

er the information half-life of a system, the shorter the turnaround **time** for information handling must be in order to maintain system integrity" (Ibid).

They add: "As the **rate of change** of a system or its **environment** increases, the half-life of the information stored in the system decreases. In a stable society (a society in a stable **environment**), the half-life of the information stored in traditions, myths, plays, and everyday wisdom is counted in the centuries and is sufficient to meet the ordinary contingencies of **decision-making**" (Ibid).

Elaborating on this **concept**, we may possibly distinguish:

- **data** half-life, as very short (but in any case longer for global **long-term data**);
- information half-life, as short to medium, according to the type of information;
- **values** and **norms** half-life, as long to very long
- wisdom and art half-life, as very long and even possibly limitless.

If the physical analogy may be pushed farther, the degradation of information should be **asymptotic** and possibly, it would never become totally extinct.

1677

INFORMATION: Implicit or Explicit ¹⁾³⁾

A frequent semantic muddle results of the use of the term "information" as applied to the postulated information **content** of, for example, the geological strata, or a crystal, or the genome.

None had any information value until their existence was discovered in the first place and thereafter progressively interpreted within some slowly constructed and evolving scientific theory (i.e., **frame of reference**)

Curiously enough, we can now agree that the "genetic code", for example, contains "information" only after giving it at least the beginnings of an explicit **meaning**.

Thus, any hypothesis about implicit information can emerge only after the initial formulation of some more or less verifiable explicit meaning applied to some entity that must be clearly identified (another construction of meaning), to begin with.

For more, see the following entry

1678

"INFORMATION" in non-human natural systems ^{1) - 3)}

The use of the term and *concept* of "information" outside of **human systems** should be at least seriously questioned.

It is, for example, sometimes stated that the DNA "contains coded genetic information". It is thus implied that the **cells** receive "**messages**" containing some "**meanings**" which influence their **behavior**, because they are able to "understand" these "**meanings**".

All of this vocabulary really reflects a deep-seated anthropomorphism. We translate and "psychologize" cellular **behavior**, using quite an over-extended **metaphor** if we remember that "informatio" is some exchange between **brains**, or, at most, between a **brain** and a computer.

However, DNA effectively "rules", at least, part of the **cell behavior**. Is thus information somehow equivalent with **behavior control**? And dare we concede a kind of volitive **action** to DNA over the **cell**? We may allow ourselves the right to use **isomorphies**, **analogies**, and even **metaphors**, but we should be careful and avoid **semantic** abuse.

1679

INFORMATION: its material media ^{1) - 5)}

J.M. RODRIGUEZ DELGADO points out the necessity to avoid confusing **information** with the various types of **media** used to transmit it: "... paper and ink can be used as **media** to carry non specific **messages** of quite different significations" (1992, p.162). He adds: "... the **functions** carrying **messages** must be distinguished... from mental manifestations. Thus, for example, the eyes and the optical nerves are needed in order to see, but they work only as non specific carriers and **transducers** of visual **forms**, which are in effect recognized by the occipital lobe and other cerebral regions" (Ibid).

In the same way, an electromagnetic wave may carry visual or auditive **messages** of very numerous different types, which can, or not, be decoded by a given **receptor**. To understand a **message** in Russian, one needs to know Russian, and not merely to hear correctly the sounds or see the cyrillic characters.

It is thus obvious that the **understanding** of information is not merely a matter of registering the medium, but requires the **learning** of the specific **codes**.

1680

INFORMATION, KNOWLEDGE and UNDERSTANDING ³⁾

R. ACKOFF and J. GHARAJEDAGHI (as quoted by M. DODDS & G. JAROS, 1994) "identify three **levels** in the **hierarchy** of **knowledge**:

"Information is descriptive: it is contained in answers to questions that begin with such words as What, Which, Who, How many, When and Where. **Knowledge** is instructive: it is conveyed by answers to How-To questions. **Understanding** is explanatory: it is transmitted by answers to Why questions..." DODDS & JAROS

add "Understanding presupposes knowledge and information. Information presupposes neither knowledge nor understanding. It does presuppose a perspective and the **purpose** of an inquiring viewer, for it is information for someone. To the above **hierarchy** one could add wisdom, as the knowledge of what to do in any given **context** of problems".

More carefully still, what is factually possible to do should be distinguished from what is socially, and ethically suitable to do.

1681

INFORMATION MATRIX ²⁾

A matrix in which the structural and metric information **content** of a system of **interrelations** is specified.

This **model** has been introduced by D. Mac KAY, who proposes to represent the **metron-contents** of **logons** as the **elements** of a diagonal information matrix" (1969, p.170). He writes, for instance: "The intended **meaning** of the **communication** is... definable as the **selection function** that is intended to exercise on the **range** of possible **states**" (1972, p.28).

This is to be related to STEINBUCH's **learning matrixes**.

1682

INFORMATION MEASUREMENT ²⁾

J.de ROSNAY explains with great clarity what is meant by information measurement, why and how to measure it and how the concept of information quantity is totally independent of its **meaning** (and is purely technical):

"In order to define conveniently what a certain quantity of information represents, one must place oneself in the situation of an **observer** seeking information about some ill-known system. It may be for example the number of possible answers to a question; or the number of solutions of a problem.

"Obtaining informations on the unknown system may lead the **observer** to reduce the number of possible answers. A total information could even lead immediately to only one possible answer: the good one. Information is thus a **function** of the relation between the number of possible answers before the **reception** of the message (P_0) and the number of remaining possible answers after **reception** (P_1)

"A very simple example: the unknown system is a pack of 32 cards. Question: what is the chance to select some predefined card?

"This question introduces an **uncertainty**, which can be metted by a relation; i.e. the number of favorable cases respect to the number of possible ones (which means: the probability to sort out the good card) As there is only one favorable case (the chosen card), this probability is of one chance in 32.

"Now, how to meet the quantity of information obtained by sorting one card? Before sorting it, there are 32 possible cases with the same probability (P_0). After sorting it, two different situations may appear:

"Either the good card was sorted. In this case, there is only one possible answer (the one in hand). The quantity of information thus obtained corresponds to the relation $32/1$, and the information is total.

"Or a useless card was sorted and there are still 31 possible answers. The quantity of information now obtained corresponds to the relation $32/31$. The information is partial.

"The information obtained in the first **situation** solves definitively the problem by reducing to 1 the number of possible cases. In the second, the number of possible cases is only slowly reduced. It thus reduces the denominator of the relation P_0/P_1 : the relation increases and the information too. This is to say that information increases when **uncertainty** decreases. This is because **uncertainty** expresses the lack of information about the unknown system.

"Finally, to meet information and to define unities, two conventions are made: information is preferentially defined in a subtractive way, better than by a relation, as information is the difference between two **uncertainties** (before and after the **message**). We substitute thus to the relation P_0/P_1 a difference of their logarithms. The second convention: as the most practical and used **code** to translate a **message** is made of two **signs**: 0 and 1, the **binary language** and the base 2 logarithms will be adopted. When using these convention, the quantity of information in a **message** is meted in **bits** (i.e. binary digits)...

"Information (quantitative) appears thus as an abstract entity, objective and devoid of any human **significance**. It is easier to understand what is a quantity of information by assimilating it to material units circulating in some **channel**: for example as water molecules in a pipe. The **flow** in the pipe is limited by its section. It is just the same for any transmitting line... as for example a telephone wire. This quantity of information is totally independent of the **significance** of the **message**: a song, the results of the horse races or the market's quotations" (1975, p.170-71).

From a different viewpoint I. PRIGOGINE and I. STENGERS state: "We may use the algorithmic theory of information proposed by CHAITIN and KOLMOGOROV: The measure of information should be the length of the **program** that would have to be given to a computer... in order to make it able to achieve the **structure** that we wish (to obtain)" (1992, p.83). Even in this case however, information is still related to an **observer**.

1683

INFORMATION, Nervous System and Brain³⁾ - 5)

Information remains potential until it is received and organized by a **brain** (in its own **auto-poietic** way), computer or any other electronic means. These latter ones acquire **meaning** by making a **difference** ... but only when reaching a **brain**.

J.J. GIBSON criticizes the pure **communication theory** of information: "The information that can be extracted from ambient light is not the kind of information that is transmitted over a **channel**. There is no **sender** outside the head and no **receiver** inside the head".

At least, there is no specific transmitting device "out there". The real world does not transmit **messages**, even if electromagnetic **waves** ramble all around us. "The world does not speak to the **observer**... Words and pictures convey information, carry it or transmit it, but the information in the sea of **energy** around each of us; luminous or mechanical or chemical **energy**, is not conveyed, it is simply there" (1986, p.242). In von FOERSTER's words: "The world is as it is" ... and that's all". As to what is inside the head, it is much more than a receiving device, even if the senses are specialized as pick up devices. We could do nothing with collected sensorial **data** if our **brain** were not **organized** to "**understand**" them, that is interpret them in relation to its acquired internal **order**, i.e. its **organizational closure**, in **auto-poietic** terms.

GIBSON's reaction against pure **mechanicist cybernetics** is anyhow understandable and quite common to many psychologists and sociologists. But his problem seems to be more **semantic** than anything else: Our senses do not collect information, nor even **perceptions**; they collect sensations. Accordingly a sentence like: "**Direct perception** is the **activity** of getting information from the ambient array of light" (p.147), is ambiguous.

→ **Knowledge (Tacit)**

More recently, A. ZELEZNIKAR still reflects somehow the **mechanicist** view and describes accordingly the nervous system and the **brain** as **receivers**, **processors** and **emissors** of information. (After all, there is something therein!)

"**Brain** is a living substance and **behavior** is a living **processing**. **Brain** is the commanding apparatus of a being's **behavior**. **Brain** is a sort of information **machine**, which enables and handles information **processes** of **behavior**. The brain also influences and in some way structurally and organizationally limits **behavior**, and **behavior** has similar developmental and **generative** influence on these **functions** (informational **processes**) which frame the so-

called mind. **Brain** and **behavior** are particular examples of information **forms** and information **processes**.

"**Brain** consists of basic informational units which are the neurons and the glia **cells**. These basic units govern the most elaborate **cognitive functions** (**behavioral processes**). The functioning of neurons in the **brain** is influenced by the **behavior**, which comes as a consequence of sensory information from other beings as well as from other environmental **phenomena**. However, groups of neurons are structured (functionally connected) within the nervous system into regional **subsystems** (regions, areas, nuclei), so that behavioral **processes** can be localized in specific areas of the **brain**. Regions of the **brain** are specialized for many different **processes**, which constitute particular behavioral information - mental and motorial. The central nervous system is a bilateral and essentially symmetrical information machinery, which consists of the following main **parts**:

"1. The spinal cord receives information from the skin, joints, and muscles of the trunk and limbs, and sends out motor information for the reflex movement and voluntary movement.

"2. The medulla oblongata is the supreme extension of the spinal cord and incorporates, in addition to other nuclei, reflex nuclei for breathing, functioning of heart, coughing, vomiting, etc.

"3. The pons and the cerebellum are supreme to the medulla. The cerebellum is modulating the force and range of movement.

"4. The midbrain is supreme to the pons and lies between hindbrain (the medulla, pons and cerebellum) and the forebrain (the diencephalon and cerebral cortex)

"5. The diencephalon contains two informational relay **structures**. The thalamus processes most of the information coming from the rest of the central nervous system to the cerebral cortex. The hypothalamus controls autonomic, endocrine, and visceral **integration**.

"6. The cerebral hemispheres consist of the basal ganglia and the overlying cerebral cortex. Both the cortex and the basal ganglia are concerned with higher perceptual, cognitive and motor information

"The medulla, pons, and midbrain constitute the **brain stem** which contains cranial nerve nuclei which in turn receive information from the skin and muscles of the head and from the special senses of hearing, balance, and taste. Other nuclei regulate **motor output** information to the muscles of the face, neck and eyes. The **brain stem** incorporates another **structure** called the reticular formation, which determines levels of arousal and awareness.

"Another structural and organizational principle of the **brain** is **parallel** (information) **proc-**

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

essing. Brain processes are served by more than one pathway. Within the **brain**, the cortex is divided into two hemispheres with four anatomically distinct and functionally specialized lobes: the frontal, parietal, occipital, and temporal. In these lobes, planning and movement, somatic sensation, vision and audition as well as **learning, memory** and emotion are processed respectively. Each hemisphere of the cerebral cortex is concerned with sensory and motor **processes** of the contralateral side of the body. The hemispheres are not symmetrical in **structure**, nor are they equivalent in **function** (information **processing**). For example the **cognitive** aspects of **language processing** are localized in Wernicke's area and in Broca's area in the left hemisphere. However, affective components of **language** as the musical intonation of speech, emotional gesturing, prosodic comprehension, and comprehension of emotional gesturing are **processes** in the right hemisphere, where their anatomical **organization** mirrors that which is for cognitive **language** in the left hemisphere.

"Even though, the **brain** is immensely complex and the **structure** and the **function** of many of its **parts** are still poorly understood, it is becoming more and more evident that it is an informationally structured and informationally organized apparatus with specific **processes** occurring in its **parts**. These **processes** – the mind – is an informational **function** which is becoming more and more understandable in modern neural science and in **informatics**" (1988, p.210-12).

Summarizing and complementing, the **brain**:

- is endowed with a complex anatomical and physiological **organization** which is improved by **learning**, which may grant it a wide **variety**;
- is endowed with a huge potential capacity for **processing** information (however this capacity remains limited);
- works in a **parallel** way, which limits the **deterministic** character of its **activity** and endows it with a certain **randomness**, which is probably the origin of **creativity**.

→ **Brain**

1684

INFORMATION OVERLOAD ¹⁾ – 4)

Any **input** of **data** which exceeds the **integration** and interpretation capability of a human **brain**.

While **communication** overload occurs in **transmission systems** as for example telephone **nets** or streets, information overload is a material (see R. WURMAN, 1989), but also, according to W. REEVES, a psycho-social **phenomenon**. Everywhere: "...the multiplicity of papers, periodicals, mail, notes, memos and

videos ... inundates our daily lives and numbs our critical thinking **processes**" (1992).

It occurs, writes K. DEUTSCH "within the minds and nervous systems of people..." and "The wider the **range** of relevant **choices** we put before a person of limited physical and psychic **resources** and capabilities, the more acute and pressing we make his problem of economy in allocating his own **time**, attention and **resources**" (1961, p.96).

Information overload is rapidly becoming a critical issue, because it interferes with the **management of complexity** (of which it is an important aspect in itself). REEVES contends "that the information explosion is a tremendous obscuring force for the the **cognitive process** within our society" (1992, p.95).

As an antidote for information overload in **situations** where the **flow** of information exceeds **processing** capacity, J. WARFIELD proposes his law of **requisite parsimony**.

→ "Christmas tree effect"

1685

INFORMATION SPACE ¹⁾³⁾

A set of "elementary **semantically** meaningful statements (or interpretable structures) together with specific relations between these **elements**" (D. GERNERT, 2000, p. 253)

GERNERT observes (like in different terms McKAY before him) that "the so-called "information theory" created mainly by SHANNON and WEAVER, was originally intended as a theory of **information transmission**. The floppy and misleading terms "**theory of information**" and "**information theory**" emerged only later and do not at all reflect the real capacities of that theory. SHANNON himself advanced a passionate pleading against the overestimation of the theory essentially originated by himself" (Ibid.)

GERNERT's definition contains terms like "semantically meaningful" and "interpretable" that clearly show that any "**information space**" is shaped by what could be called "**meaning creators**", who construct through **conversation** a common **code** of meaning. This is the real prerequisite for any explicit information.

The common code has at least two **levels**. The first is a shared **language**, as for example English, or French.

Thereafter, and within the selected language, more specific codes can be constructed as for ex. the basic definitions of **topology** or MENDELEEV's table in chemistry.

Of course, these last codes can be expressed in any spoken or written language (more or less easily)

However, any information space can become distorted, and particularly so the **fuzzy** and un-

stable **set** of terms related to human sciences and **beliefs**. The numerous interpretations given to terms like "democracy", "freedom", "development", "unconscious", etc., clearly show the unreliable character of these kinds of "information".

GERNERT also observes that in an information space: "both the elements and the **relations** may vary in the course of time"

In fact, any instantaneous "snapshot" of the set is a provisional structural state of the information space.

"**Time**" is introducing a **dynamics**, i.e. produces a series of transformed such structural states.

GERNERT states moreover: "The mathematical structure of an information space, which is given by the relations existing between the elements, may also depend on the interpretant, and furthermore, vary with time" (Ibid)

GERNERT proceeds next by developing that mathematical structure along the concepts of **links, clusters** and **similarity metrics**.

→ **Grammar-Infon-Logon- Metron**

1686

INFORMATION SPACE (Mathematics of) ²⁾

D. GERNERT tries to give a precise mathematical meaning to information space.

He quotes SNEDDON's general definition of space in his "Encyclopedic Dictionary of Mathematics": "The term space is used in mathematics for any **set** when certain types of properties are to be discussed or when it is intended to use some sort of geometrical terminology" (2000, p. 255)

Therefrom GERNERT defines "...an **information space** by a set consisting of **elements** (of a special kind), together with possible **relations** between these elements, both the elements and the relations may vary in the course of time".

"An element is understood as an irreducible unit which still carries some **semantic contents** and particularly has the character of a statement or proposition - no matter whether... - **bits, bytes**, characters, words, pixels, or other small **parts** whatsoever" (Ibid).

Further on, GERNERT describes the mathematical **structure** of the information space, which includes:

- standard and non standard **links**
- **cluster** structure
- **similarity** metrics (internal and external)
- emerging structures in dynamical **processes**

Interestingly, GERNERT states in his concluding remarks that "Information spaces in the sense outlined... can be easily modeled on an ordinary PC" (Ibid, p. 261)

1687

INFORMATION STORAGE²⁾

Natural systems store information naturally.

While the notion of information is a creation of the human **brain**, to speak of information in biological systems, in **ecosystems**, and even possibly in a quite **metaphorical** sense in physical systems seems however reasonable.

Animals and vegetals somehow **communicate**. This is also the case of **cells** in **organisms**, and even among chemical molecules.

Now, to communicate information, in whatever way, they must have it permanently available, i.e. they must have it "in store".

Information storage remains however one of the most elusive **processes** in natural systems, as to how it is done and as under which **forms**.

1688

INFORMATION (Structural)²⁾

"The number of independently variable features or **degrees of freedom** of a **representation**" (D. Mac KAY, 1969, p.176).

Mac KAY states: "Structural information is not concerned with the number of **elements** in a **pattern**, but with the possibility of distinguishing between them" (p.165).

In Mac KAY's terminology (in this case adopted from GABOR), structural information is made of units, named **logons**.

Similarly, M. MARUYAMA states: "Information is **specificity**, structuredness and improbability" (1994, p.83).

1689

INFORMATION SYSTEMS DISCIPLINE¹⁾

J.van GIGCH distinguishes the following schools of thought in this discipline (1993, p.46):

1. Sciences of the artificial
2. Systems Sciences or Sciences of **Complexity**.
3. **Decision Sciences**.
4. **Cognitive Sciences**.
5. **Computation Sciences**.
6. **Communication Sciences**.
7. **Control Sciences (Cybernetics)**.
8. Computer Sciences and **Artificial Intelligence**.
9. **Complex Systems Engineering Sciences**.
10. Complex Social **Organization Sciences** and **Management Decision Sciences**.
11. Normative **Decision Theories**.
12. **Management Theories**.
13. **Operations Research and Management Science**.
14. Social **Communication and Behavior Theory**."

Cybernetics does not only contribute to **control sciences**, but also to social **communication** and psychology, as shown by von FOERSTER's **2nd order cybernetics**.

In his paper, van GIGCH contributes an interesting table (by himself and J.L.LE MOIGNE) about "**Purposes and metaphors** of the disciplines which contribute to the **design** of an information system" (p.47).

A very different **viewpoint** is G. PATON's one. In a 1997 paper he observed that "Information system" as an expression is quite ambiguous, as "words in any **language** are overloaded with several distinct **meanings**". The problem started with Shannon's use of the word "information" in his foundational paper on "mathematical communication theory"(1948), even if he cannot be made responsible for the generalized error of later authors to refer themselves to SHANNON's theory of "information".

PATON states clearly that information is "a particular parcel of **knowledge**, acquired at a particular moment in time"(p. 69), irrespective of course to the fact that the "informed" person communicates that information to another person.

This is different from MacKAY's wording about "**logon**" (i.e. coded meaning in a linguistic and **semantic** sense) and "metron" (i.e. coding of such logon in a communication code, electronic, or whatever). However, it helps to combine MacKay's approach to Paton's one.

As to "information systems"another **ambiguity** emerges. PATON observes: "if you think of information as existing out there in the world"(in a **computer** for ex.) ..."you are working with information as a **resource**, just like finance. All the dangers of the take-over by accountants now apply to take-over by I.S. managers"(Ibid, p. 70)

And of course, IS managers become **controllers** aiming at making a profit by installing suitable valves within the communication **channels** (and eventually also installing censure or manipulation)

Accordingly, PATON considers that "information systems", before becoming a "resource", are "intellectual **constructs**"(p. 71). As such, they are open systems, very different of the boxed products that become protected commercial items, as for example patents, software packages or any other finished product.

1690

INFORMATION: the autopoietic view¹⁾³⁾

S. BRIER writes: "The system does not receive objective information from outside as a **stimulus** to which it responds. Instead its **organization** is perturbed by some things happening in the surroundings and its "answer" is an internal **adjustment** to maintain its organization. It is reacting to its own internal **network**. Information therefore is not something outside, but rather is a **phenomenon** created inside the **organism**"(1995, p. 7)

This is Maturana's version. QVORTRUP observes that his theory is "somewhat **solipsistic**"(1993)

Of course, human beings are unavoidably "somewhat" solipsistic. It must be the only condition for maintaining **identity** within a **range** of adaptive **change**

1691

INFORMATION THEORY^{1) - 3)}

Under the general wording of Information theory widely different subjects have been considered:

- 1- A theory of **transmission** of information through a physical **channel**, which is in reality a **theory of communication** (in the physical sense).
- 2- A quantitative theory of information, which considers for example the quantity of **bits** necessary to convey some information.
- 3- A theory of **meanings**, which looks into the transfer of significant information from a **semantically** able **emissor** to an equally **semantically** able **receiver** (or many).

D. Mac KAY expresses this idea: "Information theory is concerned with the making of **representations**, i. e. **symbolism** in the most general sense" (1972, p.161).

According to Mac KAY: "General information theory is concerned with the problem of measuring **changes** in **knowledge**. Its key is the fact that we can *represent* what we know by means of pictures, logical statements, **symbolic models**, or what you will. When we receive information, it causes a **change** in the **symbolic** picture, or *representation* that we could use to depict what we know" (p.42).

Still in Mac KAY's words: "The scope of information theory thus includes in principle at least three classes of **activity**: 1) Making a **representation** of some physical aspect of experience. This is the problem treated in *scientific* or *descriptive* information theory;

- 2) Making a **representation** of some non-physical (mental or ideational) aspect of **experience**. This is at the moment outside our concern, being the problem of the Arts;
- 3) Making a **representation** in one **space B**, of a **representation** already present in another **space A**. This is the problem of **communication theory**, B being termed the receiving end and A the transmitting end or a **communication channel**" (p.162).

Thus, at least in the realm of **symbolic coding**, **communication theory** is included within information theory.

However, a serious confusion besets the whole subject. For example, Mac KAY writes: "SHANNON wisely insisted that the **concept** of "meaning" was outside the scope of his theory"

"This innocent statement by SHANNON has given rise to two unfortunate consequences:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"In the first place the original sense of SHANNON's warning has sometimes been forgotten and he is credited with the view that the whole theory of information (which includes his own theory of the unexpectedness of information as a vital part) has nothing to do with "meaning".

"Secondly, and largely in consequence of this, the idea has become current that the whole subject of **meaning** is not satisfactory for the information theorist. "Subjective", "vague", "dangerous", are the adjectives with which it is often smothered" (p.80).

From a different angle, M. MARUYAMA has observed that SHANNON's Information theory: "... was trapped in a classification **epistemology** which sees a **structure** as consisting of **elements** which tend to behave independently. In SHANNON's theory, the most probable or "natural" **state** of a system is that in which each **element** flips its own coin regardless of the other **elements**. The amount of information which a **structure** conveys is defined as the degree of departure of the **structure** from such probable **states** of nonstructure. The higher the improbability of the **structure**, the higher the amount of information. In this **epistemology**, **structures** tend to decay to more probable nonstructures" (1976, p.201).

In synthesis, SHANNON's Information theory is somewhat at odds with the systemic **viewpoint**: a bag of loose flipping **elements** is not a significant **network**, and still less a system.

The confusion about the real meaning of "information" in SHANNON and WEAVER remains deeply ingrained.

D. GERNERT still felt in year 2000 the need to write the following:

"The so-called "information theory", created mainly by SHANNON and WEAVER, was originally intended as a theory of information transmission. the floppy and misleading terms "theory of information" and "information theory" emerged only later and do not at all reflect the real capacities of that theory. SHANNON himself advanced a passionate pleading against the overestimation of the theory essentially originated by himself.

More and more- albeit still reluctantly- the idea is gaining broader acceptance that a theory of information which really deserves the name must also account for the **semantic** and **pragmatic** aspects of information" (2000 b, p.253)

1692

INFORMATION THEORY (Relativistic) ^{2) - 4)}

A theory about the nature of information, taking in account the "multiplicity of informative referentials" (adapted from G. JUMARIE, 1980, p.83).

JUMARIE writes as a conclusion to his enquiry: "A fundamental triplet seems to be essential for the definition of the concept of information, i.e.: the system S, material support of

that which is significant; UD, the universe of discourse that contains what is meant; and the individual **observer** R who interpretes it all in his personal subjective referential" (p.82).

S is the observed **universe**, and R is the observing system. Between both there is a **feedback cycle**, formerly well explained by R. VALLÉE through his **epistemo-praxeological loop**.

There are of course many R's who, together, generate by **consensus** a **universe** of discourse UD, by comparing their different **experiences** of the observed Ss. This is a **semantic universe** whose roots are socio-cultural.

The general result is the relativity of **information**.

1693

INFORMATION TIGHTNESS ¹⁾

Invariance in time of the properties of a system (adapted from W.R. ASHBY, 1958, p.202).

When a **protocol of observations** contains **redundancies** and thus allows for statistical reduction (compactation in ASHBY's vocabulary – or the somewhat different **compression** in CHAITIN's sense) something may be stated about the **behavior** of the system only if its properties observed through the **protocol** are "not subject to unpredictable vagaries" (Ibid), i.e. "information-tight", at least so far as these properties are concerned" (Ibid).

The concept seems somehow related to MATURANA and VARELA's **organizational closure**, and may even have been one of its sources.

1694

INFORMATION TRANSFER (Some elemental structures of) ²⁾

Even very simple **graphs** show how varied are the modes of information transfer in a **net** of very few **elements**, as shown in some **graphs** hereafter reproduced from a paper by M. KOCHEN (1957, p.37)

see figure associated to entry 3247

M. KOCHEN gives 21 theorems related to organized **structures**.

1695

INFORMATION TRANSMISSION ²⁾

It is now evident that information is a very pervasive feature of all kind of systems, under widely different forms as for example genetic, ecological, organizational or cultural.

Its transmission takes place in various ways: physical, biochemical, demographic pressures, through gesture, **languages**, etc.

One of the most interesting is by reciprocal **perception** as in fish schools, or among ants or bees. Another is through the observation of formerly constructed **structures** (**stigmergy**).

It even now seems that in human societies, information through electronic devices is becoming *kind of autonomous* as observed by S. GOONATILAKE: "... because of the internal **dynamics** of the expanding **exosomatic** system, new **flow** lines will develop organically, radiating themselves into new **niches** ... **artificial intelligence** devices will give rise to novel solutions which eventually will lead to new **flow** lines" (1991, p.120).

1696

INFORMATIONAL SUBSTANCES ¹⁾⁵⁾

Stafford BEER emphasizes the importance of Candice PERT discovery that peptides acting as opiate **receptors** are present all over the body (Molecules of emotions" _ (1999, p. 452-54)

He argues that this discovery of what he calls "informational substances" leads to the unification or at least the bridging between neuroscience, endocrinology and immunology.

In the words of C. PERT herself: "The way in which peptides circulate through the body, founding their target **receptors** in **regions** far more distant than had ever previously been thought possible, made the **brain communication** system resemble the endocrine system, whose hormones can travel the length and breadth of our bodies: the brain is like a bag of hormones!" (as quoted by S. BEER)

1697

INFORMATION-POWER Hypothesis ¹⁾

"In systems which survive, the **component** with the most relevant **information** available to its **decider** is the one most likely to exercise power over or elicit compliance from other **components** in the system" (J.G. MILLER, 1978, p.100).

MILLER, gives the following example: "Some researchers have shown that, in small **groups**, the member who receives the most information is most likely to be chosen leader" (Ibid).

In biological systems, it seems that the hypothesis applies to the **brain**.

1698

INFRASTRUCTURE ¹⁾

The **set** of basic **structures** needed for the existence and **development** of a system.

This is basically an economic and social concept proper to **human systems**, which are constantly evolving and creating new **functions** and **structures**. Many of these are not basic to the **survival** and good **performance** of the system. Some may even reflect harmful developments.

1699

INGESTOR ²⁾

"The **subsystem** that brings **matter-energy** across the system **boundary** from the **environment**" (J.G. MILLER, 1978, p.3).

This is one of the 20 **critical subsystems** in J.G. MILLER's general taxonomy of **Living Systems**

1700

INHERITANCE OF ACQUIRED CHARACTERISTICS ^{1) - 4)}

The famous controversy about Lamarckian inheritance of acquired characteristics has never been definitively settled.

We need an explanation about the: "... **process** whereby the newer inventions of adaptive **behavior** are sunk deeper into the biological system of the **organism**", as stated by G. BATESON. (1973, p.225)
→ ("**Archetype**").

In cultural systems among humans (and possibly among some social superior animals) the **model** of **transmission** of **knowledge** and **behaviors** from one generation to the following through **imprinting, training and learning** (KORZYBSKI's **time binding**) seems to be satisfactory. It is even possible that this **phenomenon** inspired the very Lamarckian concept.

On the other hand, no convincing **mechanism** of inheritance of phenotypically acquired biological characters, other than genetic mutations, has yet been found.

Observations of social animals seems to indicate that only individually acquired **information** can be transmitted, by imitation, or **learning**.

1701

INHIBITING EFFECTS ^{1) - 2)}

The negative effects on **efficiency** or **growth** of **elements**, **populations**, or **subsystems** due to excessive closeness or **overcrowding**.

Any **element** or **subsystem** needs a sufficient **space** for its correct functioning. Furthermore, it benefits from **heterogeneity**, because it diminishes unfavorable **competition** between **elements** of the same type when they are sufficiently spaced. In M. MARUYAMA words: "You would not build two post offices next to each other" (1994, p.80).

Spacing is thus useful, as it contributes to avoid inhibiting effects.

Another and more subtle type of inhibiting effects which has been discovered recently is the killing by a parasite fungus of the roots of the black cherry tree of saplings of the tree growing within about 15 meters of the adult one.

As the saplings of other trees are not affected, this amounts to a ecological **dispersion mechanism**

1702

INHIBITION ¹⁾

A **constraint** strong enough to block a **process**.

The inhibitor blocks the **process** by substituting itself to some **element** crucial to the **process**.

In many cases the inhibition process is coupled with an **excitation** process. Their alternance allows the system to maintain itself in a restricted **range** of **stability** conditions. Excessive or too frequent excitation in some **critical** process may destroy the system, if not compensated in due time.

In many chemical and enzymatic reactions the inhibitor is more strongly reactive than the normal **substrate** which feeds the **reaction**. In some cases inhibition is irreversible, i.e. when the newly created bond is so strong that it cannot anymore be broken, or when the **substrate** is overwhelmed. In other cases however, inhibition remains reversible.

The concept seems useful at least if used carefully, as a heuristic **metaphor** in psychology, economics and possibly in **ecology** and social sciences.

A recent example could be the disappearance of cod's reproductive capacity under the pressure of overfishing on the Grand Banks of Newfoundland and its possible irreversible replacement by other species in its former **niche**. This type of **phenomena** in ecosystems is well documented.

→ **Catalysis; Constraint; Far-from-equilibrium condition; Instability; Oscillators; Periodicity; Stability (Poly-)**

1703

INHIBITION (Cross) ²⁾⁵⁾

A mechanism of mutual negative **association** between antagonistic **elements** or **subsystems**.

Cross inhibitions are frequent in biological, ecological or economic **processes**.

They are based on combinations of **positive** and **negative feedbacks** and are needed to maintain a regulated process within defined or pre-determined **limits**.

J. HOLLAND describes for ex. cross inhibition in **cells** associations and in chromosomal alleles (1992, p.60-64).

1704

INITIAL CONDITIONS (Sensibility to) ^{1) - 2) - 5)}

A condition in a **nonlinear** system by which very slight differences in initial conditions lead to considerable ones in the later **behavior** of the system.

More than one century ago, H. POINCARÉ, in his study "On the **three bodies problem** and the equations of dynamics" (1889), showed the impossibility to determine in an absolutely rigorous way the future positions of three (or N) interacting bodies: the problem cannot be satisfactorily integrated.

The basic cause of such a situation is that a 3-bodies (or more) system is not **deterministic** in a **linear** way.

N. PEGUIRON writes on this topic: "This sensibility to initial conditions, characteristic to any **long term deterministic prediction**, showed by POINCARÉ, is a general case in classical mechanics: only some quite simple cases escape to this, as for example the two-bodies system" (1989, p. 11).

In more complex cases, the discrepancies, not being still important, may remain unheeded during more or less a long **time**. This is what allows for example for apparently rigorous **prediction** of the astronomical **trajectories**. However, at long or very **long term**, it has been recently demonstrated that even the solar system is not absolutely stable.

PEGUIRON comments this situation in the following way: "**Indeterminism** in classical mechanics does not appears in their governing equations, but through the impossibility to apply them to a system not devoid of external influences. Clearly, in this case, the isolation **process** displays a property, (rigorous) **determinism**, which is not proper of real systems" (p.11).

The sensibility to initial conditions leads to **chaotic behavior**, i.e. to **unpredictability**, which grows with **time**. However this does not imply the total disappearance of **global determinism**.

POINCARÉ established the bases for the study of **deterministic chaos**, when he created the concepts of **limit cycle**, transverse arc and section normal to the **trajectory**, now called "**POINCARÉ's section**".

The non-instantaneous **transmission** of local causes and the **non-simultaneity** of the resulting **effects** makes up another way to account for partial and local breaches of **determinism** and of the unpredictable character of the **trajectories bifurcations**.

→ **Sensibility to initial conditions**

1705

INLET ^{1) - 4)}

A **channel** or pocket within a system or **subsystem**.

An inlet corresponds to the penetration of part of the **environment** within the system. It is however more of a kind of internal extension of the **boundary**. In some sense, the whole of the digestive or the respiratory tract for example,

could be considered as inlets, since their exchanges with the system proper take place only locally and through specific **input** (or **output**) **transducers**.

Inlets may end up as inclusions if the **connection** with the **environment** is completely severed. Such inclusions are generally, but not always, assimilated or eliminated after some **time**.

Social, economic and cultural **analogies** could be explored, as for example, foreign commercial communities within some nations or empires: Venetian or Genovese establishments within the Byzantine Empire was possibly a case.

→ **Frozen core**

1706

INPUT^{1) - 2)}

Any **matter**, **energy** or **information** that a system or a **subsystem** receives from its **environment**.

K. BERRIEN proposed to distinguish between **maintenance** inputs: "those which energize the system and make it ready to function", (i.e. **energy** and **matter**) and **signal** inputs: "those which provide the system with **information** to be processed" (1968, p.25).

Any input is obtained from a specific **source**, which should be identified as precisely as possible in order to establish the absolute or relative **dependence** of the system in relation to it. It is very important to know the degree of probability that the **source** will be able to produce the required input in quantity as well in quality during the whole span of **time** that the system will need it.

This implies a study of the **rate** of production of the input, of the possible **perturbations** that could affect it, and of **competition** from other systems to secure their own needs.

As some inputs may be dangerous for the system, it is also necessary to detect these, in order to avoid them. It should be noted that many systems receive a **variety** of inputs while being unaware of it; as for example our absorbing numerous pollutants which cannot be directly perceived by our senses.

Inputs must cross **boundaries** or **interfaces**. The way they do it in **space** and **time** is also a very important feature of the **interrelation** between the system and its **environment**.

Last but not least, the **transformations** of the input within the system are of utmost importance in relation to its correct **performance** and even, in some cases its very **survival**.

1707

INPUT BOUNDARY²⁾

"... the **set** of all **functions** which relate **environmental variables** to system **variables** in a unidirectional fashion" (W.T. POWERS et al., 1960, p.65).

These authors state that "... **environmental variables** affect, through some physical device, a system **variable**, but the device does not work backward" (ibid).

This concept is intriguing: since, while it characterizes a boundary as functional (as it really is indeed), it leaves open the question to find out where does really a boundary begins and ends. Is the stomach internal lining, for example, as a **part** of the digestive tract also a **part** of the boundary?

1708

INPUT PROCESSING^{1) - 2)}

"The **operations** that provide for (1) the **interaction** between the system and its **environment**, (2) the identification of systems-relevant input, and (3) the introduction of systems-relevant input into the system" (B. BANATHY, 1973, p.87).

Subsystems also have input processing devices. In this case, inputs generally come from other **subsystems** (**invironment**).

The following critical **subsystems** described by J. MILLER take part in input processing: **Boundary** (in general), **ingestor** (for **matter** and **energy**), **input transducer** (for information).

1709

INPUT TRANSDUCER²⁾

"The sensory **subsystem** which receives from **subsystems** or **components** within the system, **markers** bearing **information** about significant alterations in those **subsystems** or **components**, changing them to other **matter-energy forms** of a sort which can be transmitted within it" (J.G. MILLER, 1978, p.3).

This is one of the **20 critical subsystems** in MILLER's taxonomy of **living systems**.

1710

INPUT-OUTPUT ANALYSIS^{2) - 5)}

A technique for the study of **flows** in the economy in general or in an enterprise.

This technique can be used for **planning** or **forecasting**. It aims at the clear definition of the **interconnections** between some defined inputs and the corresponding outputs. This is generally done by using **input-output matrixes** (see hereafter). In this way, it becomes possible to establish the amount of output than can be obtained from a specified input, or conversely the amount of input needed to obtain a specified output, and eventually the **changes** that should be introduced in their reciprocal balance.

The technique can be applied in very numerous different cases relating inputs and outputs of materials, **energy**, **information**, labour, financial **resources**, or production of some item in relation to the market, etc...

There must be of course basic assumptions related to the constancy of **environmental conditions** and, for **planning** and **forecasting**, a **time** horizon of credibility about the **stability** of the same.

Input-output analysis can also be used in the study of **ecosystems**.

1711

INPUT-OUTPUT MATRIXES⁵⁾

The **representation** through a table with lines and columns of **flows** within a system.

This method has been introduced in economy by W. LEONTIEFF (1956).

The **flows** can be of **matter**, **energy** or **information** and take place between structural **elements** in the system. These matrixes are an alternative **representation** for **network diagrams**, totally or partly. As stated by H. ODUM: "Representing systems in this way is a first step in the use of techniques of matrix algebra by systems analysts". He adds, however: "A pertinent step after **description** as a matrix is to count the possible **relationships** that may have been overlooked" (1971, p.21).

This is indeed a many times forgotten necessity.

1712

INQUIRING SYSTEM (Design of the modern)¹⁾

Under this general title J.P.van GIGCH, J.L. SNELL and the Argentine authors E. HERRSCHER, P.E. PAVESI and P.F.J. PAVESI, published a series of papers in "Systems Research" (1988-1997). Their general aim has been to investigate the historical roots of the concept of inquiring system in the works of philosophers, scientists and even novelists of the past.

Among these appear Thales (600 B.C.), Lull (1232-1315), Descartes (1596-1650), Condillac (1715-1780), Kant (1724-1804), Destutt de Tracy (1754-1836), Cassirer (1874-1945), Hesse (1877-1972), Schrödinger (1887-1961), McCulloch (1898-1969), Feynman (1918-1988)

van GIGCH also considered the new approaches resulting from the introduction of the **computer** (1988). He may still conceivably return to this last subject since the accelerated evolution of the recent years.

1713

INQUIRING SYSTEMS (Hierarchy of)^{2) - 3)}

J.van GIGCH integrates inquiring systems into a more general **process** of **knowledge** formation: "The **hierarchy** of conceptual **levels** where higher **levels** of logic lend metarationality to lower **levels** can also be found in the **process** of **knowledge** formation... The **hierarchy** consists of four levels:

"**Level 1**: Or user's **level**, provides us with **facts** from **observations** of the real world. The problem of *universe of discourse* of **level 1** consists

of making **choices** among those **facts** to prepare a *descriptive model* of the universe of discourse.

"**Level 2: (the observer's level)**, the descriptive **model** is elaborated into an *explanatory model*. Here the problem consists of making **choices** among descriptive **models** to elaborate *hypotheses* and the most plausible *explanatory model* which accounts for the observed **facts**.

"**Level 3: (the designer's level)**, explanatory **models** become *prescriptive models*. The **designer's universe of discourse or problem** is to convert explanatory **models** into *prescriptive models or theories*. The role of an explanatory **model** is to merely account for a system's **behavior ex-post**, whereas the role of a prescriptive **model** is to anticipate its **behavior ex-ante**.

"**Level 4: (the epistemologist's level)**, choice among prescriptive **models** or theories leads to the elaboration of an *epistemological model, or paradigm*" (1986b, p.92-3).

This is the general recipe for inquirers and **designers** to avoid being naïve.

1714

INQUIRY (Cycle of)²⁾

P. LEDINGTON describes as follows the "five steps (that) provide an organized approach to inquiring about the **situation**":

"First, investigate the **situation** and gain an intuitive **understanding** of it;

"Second, grasp some basic names for ideas that are felt relevant to that **understanding**;

"Third, formalise the ideas into **models**, using some **rules** of formalisation;

"Fourth, compare the **models** with the features of the **situation** and assess the areas of match and mis-match;

"Fifth, evaluate attitudes towards the **situation** in terms of **problems** and courses of **action** based upon the revised **understanding** that has emerged from the formal **process** of inquiry" (1992, p.51).

As systems and **situations** have the bad habit of never stay put, S. BEER should surely add: and start it all over again, and again, as many times as needed.

1715

INQUIRY SYSTEM^{1) - 3)}

"A system of interrelated **components** for producing **knowledge** on a problem or **issue** of importance" (I.I. MITROFF and H. A. LINSTONE, 1993, p.29).

This definition is adapted from C. WEST CHURCHMAN (1971), who described the evolution of the concept of inquiry system from LEIBNIZ to SINGER and proposed his own synthesis, within the frame of a wide epistemological analysis.

CHURCHMAN's views have deeply influenced the following generation of systemists interested in inquiry and inquiring systems.

MITROFF and LINSTONE make the following points:

"First, every I.S. has or accepts, distinctive **inputs** from the "outside world"... The **inputs** that a particular I.S. recognizes as legitimate are not necessarily recognizable by other I.S.'s...

"Second, different I.S.'s employ different kind of **operators** (i.e.) the **mechanism** that operates or works on the basic **inputs** to transform them into the final **output** of the system, or **knowledge**...

"Third, the **output** of an I.S. is what the system regards as a valid **knowledge** for **action** on an **issue** of importance

"Fourth, the most critical **component** is known as the *guarantor*..., the **component** guaranteeing the **operation** of the entire I.S. itself" (p.30).

These statements imply that any I.S. is based on **criteria** defined by the inquirer or, in other words, is based on definitory subjective appreciations. This is unavoidable, but rarely perceived. Methods to clarify those **criteria** should always be used (See for example J.van GIGCH's **meta-levels**, J. WARFIELD's methodology to manage "**spreadthink**" (i.e. seek **consensus** when facing widely divergent opinions) and G.de ZEEUW's **invisibility**).

Note: Most authors do not seem to make a distinction between "inquiry" and "inquiring" systems. In some cases, "inquiring" systems could be compared with H.von FOERSTER "**observing**" systems.

1716

INSTABILITY^{1) - 2)}

Condition of a system or **process** led by a **fluctuation** of a critical **variable** out of its **homeostatic stability channel**.

Dynamic stability's main characteristic is that the system **oscillates** periodically within defined **limits** of **amplitude**, without ever leaving the established **fluctuations channel**, or **domain of attraction**.

Instability, on the contrary is a **runaway process** with a finite **time** course, through a succession of ever amplifying **oscillations** which lead the system closer and closer to the **limits** of its **stability channel** until a critical **threshold** is neared and the **process** undergoes a basic **change**. At that point the system reaches **metastability** and the slightest supplementary **disturbance** – even a small **random** "push" – turns it unstable, destroys it (the most common case for individual systems) or, rarely, shifts it toward a different form or **organization**.

Instability is closely related to **environmental** conditions, as stated by R. FIVAZ: "...instabilities have the property to bind conditionally the internal **structure** of the system to the value of an external **field**. This conditional bind is certainly a necessary ingredient to construct a **complex system modelization** inasmuch as such systems interact with the outside constantly, albeit selectively.

"In addition, real **situations** are characterized by unpredictable variations in the **environment** which submit systems to a succession of independent and **random fields**" (1991, p.22).

The most significant perturbing influence for a system is a high increase of the rate of **energy** intake, which is the factor that leads it to giant **fluctuations**. In **human systems**, such increase is induced by the system itself (technical advances in the captation and uses of **energy**).

More recently, the **boundaries** of **stability** and instability have become quite blurred, through our new **understanding** of **deterministic chaos**. It becomes rather difficult in the case of a **nonlinear system** to know if it is inherently stable, **metastable** or unstable, since it may fluctuate wildly and frequently bifurcate, with the possibility that it may cross an **instability threshold**.

In some cases, the concept of instability should however be relativized. According to C. HOLLING, many systems have alternative **dynamic stability** conditions, within more global conditions of **stability**, as they may leap from one **domain of attraction** into another under the impact of some very strong and unusual **perturbation**. HOLLING writes: "...many examples for the influence of **random events** upon natural systems... suggest that instability, in the sense of large **fluctuations**, may introduce a **resilience** and a capacity to persist. They point out the very different view of the world that can be obtained if we concentrate on the **boundaries** to the **domain of attraction** rather than on **equilibrium states**. Although the **equilibrium-centered** view is analytically more tractable, it does not always provide a realistic **understanding** of the system's **behavior**" (1976, p.81).

In such cases, we could possibly speak of an **endogenous ergodic** instability. While unstable, the system at least keeps its **identity**.

An interesting comment by Y. SINAI connects instability with **randomness**: "The more unstable the movement, the more **stable** become the manifestations of **randomness**. The instability of a non-aleatory **dynamics** leads to the rise of **randomness**" (1992, p.87).

1717

INSTABILITY (BÉNARD's)^{1) - 5)}

A **dissipative structuration phenomenon** that appears in a heated liquid.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This **phenomenon** discovered in 1908 by the French physicist BÉNARD, has been the first observed **dissipative phenomenon**, ... in a jar of heating water. It implies the **transition** from a microscopic **level of action** to a macroscopic **level of organization**, which embraces a gigantic number of micro-**elements**.

R. LEFEVER and I. PRIGOGINE describe it as follows: "For a small difference of temperature, heat is conveyed by conduction, without any convection; but when the imposed temperature **gradient** reaches a **threshold value**, the **stationary state** (the fluid's **state** of "rest") becomes **unstable**: convection arises; it increases the **rate** of heat transfer and corresponds to the coherent motion of a huge number of molecules. In appropriate condition, the convection produces a complex **spatial organization** in the system" (1986).

Dissipative structuration transforms **chaos** into **order** (J. BRIGGS and F.D. PEAT, 1989, p.137).

Of course, this is not "a free lunch". As noted by PRIGOGINE: "The price is **entropy**! When we heat the system from below, most of the heat **flow** is lost, but some part of it is used to produce the **pattern**" (1989, p 7).

The resulting **organisation** takes the form of **hexagonal convection cells**. (See: "Hexagonal space filling").

1718

INSTITUTE FOR THE STUDY OF COMPLEX SYSTEMS (ISCS)¹⁾

This Institute is seated at 119, Bryant Street, Suite 212, in Palo Alto, California, CA 94301, USA.

Under the leadership of Peter CORNING, it focuses on "functional approaches to the **evolution** of **complex systems** as opposed to **autocatalytic**, **self-organizing** or law-governed approaches". Its "roots are in biology, not physics" (personal communication)

1719

INSTITUTIONALIZATION⁴⁾

"The translation of abstract cultural **elements** into action **norms**, **roles** and **groups** in order to instaure a more or less direct **control** upon social **interactions**" (After J.C. LUGAN, 1993, p.48).

This **process**, described by T. PARSONS, leads to the shaping of social **structures**, and tends to reduce **fluctuations** within the **social system**. It is a form of **regulation** and leads to social **homeostasis**.

It may however become a stumbling block if a **social system** faces a need for really crucial **changes**.

1720

INSTITUTO ANDINO DE SISTEMAS (I.A.S.)¹⁾

I.A.S. is the Peruvian Systemics Institute. It was founded in the 80's in Lima Peru by Eng. R. RODRIGUEZ ULLOA, who is still its President to date (2004). It has also a branch in the northern Peruvian city of Trujillo.

It publishes a series of pamphlets on "Systems Thinking and Total Quality" (in Spanish) as well as the six-monthly Journal "Sistémica", on "the inter- and **transdisciplinary management of complexity**". It also co-published Ch. FRANÇOIS's Spanish "Diccionario de Teoría General de Sistemas y Cibernética" (1992) and R. RODRIGUEZ DELGADO's "Teoría de Sistemas y Gestión de las Organizaciones" (1994).

I.A.S. organizes tutorials and seminars on a variety of subjects, mainly oriented towards the **management of complexity in organizations**. It also organizes "International Work Conferences". The 2nd one and most recent took place in Trujillo on "Sustainable **development** in societies and **organizations** with limited **resources** and opportunities" (December 1994), with the presence of Argentine, Chilean, Colombian and Mexican systemists.

Information on Congresses and Seminars of the IAS are at:
<http://www.iasvirtual.net>

1721

INSTRUCTION (Systemic)⁴⁾

A method aiming at a better **integration** of specialized **knowledge** with a global **understanding** of complex **situations** and systems.

Not only did instruction slowly pushed **education** (psychical and social) out of the classrooms and auditories. It has also gravely curtailed its own scope by encouraging more and more narrow specialization in evermore limited and isolated fields. This undoubtedly corresponds to the practical needs of our highly technified contemporary societies and seems thus unavoidable.

It however leads to a growing **segregation** between evermore numerous and particularized disciplines, and this destroys the capacity for synthesis, intercommunication and global approach to **complexity**.

Systemic instruction seeks to restore such a capacity for synthesis by creating a conceptual and methodological **language** usable to create bridges between specialists from different disciplines.

The acquisition of any specific **knowledge** seems to be a **process** of creation of **frames of reference**, i.e. the specific cerebral **organization** which reflects these frames and the capacity to modify them, or create new ones, when necessary.

This is probably closely related to the progressive **organization** by adequate training of neural **circuits** in the neocortex.

The systemic **language** contributes to this **process** by the use of fundamental and confirmed **analogies** and, still better when possible, **homomorphies** and **isomorphies** between structural and/or functional **models** elicited from various disciplines. It also establishes general concepts related to the global aspects of the **situations** and systems under **observation**.

This dictionary aims to make a critical census as complete as possible of these **analogies**, **homomorphies**, **isomorphies** and concepts as well as of the ways and means to use them.

1722

INSTRUMENT¹⁾

"An **object** that co-produce the outcome of an individual's or system's **action**" (R.L. ACKOFF & F.E. EMERY, 1972, p.31).

ACKOFF and EMERY write: "The co-production is itself produced by the individual or system. Thus an instrument is a device used by a functional individual or system in its functional **behavior**... The instrument employed by an individual or system operating at any functional **level** is always at a lower **level** than the **level** of the individual or system that uses it" (Ibid).

→ **Man-machine system**

1723

INTEGRABILITY²⁾

V. CROQUETTE states: "...all **linear** problems can be integrated". (1989, p.68).

Such problems correspond to the **behavior** of systems submitted to only one or two independent periodic **oscillations**.

CROQUETTE adds: "On the contrary, for **non-linear** systems, the determination of the characteristic **modes of behavior** is quite more difficult and, in most cases downright **impossible**. The notion of non-integrability is thus closely related to the **nonlinear** character of the system, even if there are some integrable **nonlinear** systems, as the pendulum, for example" (Ibid).

1724

INTEGRATE AND FIRE MECHANISM^{2/4)}

A natural mechanism that leads to the **synchronization of two oscillators**.

Ian STEWART writes: "... the **oscillations** are created by a **mechanism** known as integrate and fire. In such a setting some quantity builds up (that is, the **phase** increases) until it reaches a **threshold**. Crossing this value triggers a sudden action - fire (or in the case of fireflies, flash) - after which the quantity resets to zero and starts to accumulate again...

"Such **oscillators** are said to be "coupled", meaning that one affects the **state** of the others. The classic example is the **observation** made by the great Dutch physicist Christian

HUYGHENS (1629-1695) that pendulum clocks on the same shelf affect one another through the vibrations of the shelf" (I. STEWART, 1999, p.86).

As the **elements** in the **coupled oscillators** interact in an ordered and **cyclical** sequential way, this **phenomenon** is thus a very basic social one.

1725

INTEGRATING MECHANISMS^{1) - 4)}

Integrating mechanisms are a general feature of organized systems. They exist at every **level** of **complexity**, at least from the atomic one up to the social one. They are always relational mechanisms, based on some complementarity or some response to an external **constraint**.

An extraordinary biological example is the production of acrasin in the slime mold *Dicystostelium discoideum*, when starvation sets in within a **colony** of this **organism**, as a result of overpopulation within an **environment** limited in **resources**. (J.T. BONNER, 1988, p.231).

The search for the corresponding mechanisms in **sociosystems** is not yet systematic and no definitive conclusions exist until now. However, **norms**, beliefs, ideologies and scientific or philosophical **paradigms** are probably integrating mechanisms, resulting from the necessity to collectively face **environmental** pressures.

1726

INTEGRATION^{1) - 2)}

1) An **operation** intended "to make the **components** of a system increasingly fused and interactive" (B. BANATHY, 1973, p.87).

2) The state of a **whole** whose **components** are closely interactive.

W.C. ALLEE et al write: "Division of labor and integration are associated principles. Integration has no **function** unless there are differentiated **parts** that must act in relation to the **whole**. Specialization of **function** cannot occur unless the specialized **parts** are coordinated. Efficient **homeostasis** follows an increase in the special **functions** of the integrated **parts**. These principles apply to every **organismic level**, from the **cell** to the **ecosystem**, but are particularly well exhibited by the **population** of a **colony** of social insects" (Quoted by Ch.H. LAWSON, 1963, p.114).

R.N. ADAMS states: "...when a **level** is formed it not only receives **inputs** from its **components** but also involves **self-organization** at each **emergent** higher **level**" (1988, p.183).

Any progress towards integration supposes **constraints**: any integrative **operation** specifies well defined **interactions** among **parts**, generally by preventing other **interactions**. M.

DODDS and G JAROS write: "Integration... represents **pattern** and **order**, it tends toward simplicity and **cohesion (morphostatic)**" (1994, p.1417).

It also supposes the **emergence** of a higher **level communications network**, whose links precisely define the newly instated **constraints**.

Composite systems are less integrated than **complex systems**. **Complexity** is indeed closely related to integration since the better specified and more precise definitions of **interactions** tend to lead towards more **differentiation** of the various **parts** of the system, which thus becomes more **heterogeneous**.

Integration of very **complex systems** is more difficult and costly, as the number of **components** and **subsystems** increases, since more – and more complex – **regulators** are necessary to maintain **homeostasis**.

Integration is, in principle, an irreversible **process** or **state**. The break-up of the prescribed **interactions** – even when crossing quite narrow **limits** – leads to the systems **disintegration**.

The integration **process** is linked to the progressive emergence of **constraints** within the system: **rules** of **behavior** of the **elements**, **rules** for their **interactions**.

In ASHBY's terminology, an integrated system is more or less richly **joined**.

There is an optimum **level** of **integration** for any specific system, which is, unfortunately, very difficult to perceive and, still more so, to specify. Below this **level**, the system is not as efficient as it could be. Above it, it becomes clogged and slow to react to any inside or **environmental disturbance**.

In any case, the system retains its **adaptability** and **efficiency** only when it still counts with sufficient **redundancy**.

1727

INTEGRATION as a dynamic process^{1) - 2)}

As a process, integration is in J. KHAN's words: "The **coordination** of all **elements** in a shared and mutually beneficial **order**" (1992, p.991). Such a **process** is progressive, but may result, at a critical moment, in sudden clinching.

As observed by J.L. LEMOIGNE, integration is not a **state** of a system, but on the contrary an aspect of its **dynamics**.

The system's **activity** must be **permanently** coordinated, and not merely once under the guise of a stiff diagram.

LEMOIGNE writes: "The static diagram of a **net**, many times termed in theory of **organization** as a flow chart (note: in French: *organigramme*), only shows the prohibited (or *supposedly obligatory*) **interconnexions** and does not reveal by itself the potential properties that could result from (some other) possible **connexions**" (1977, p.194).

Any **description** of a system under the guise of an unique instantaneous and supposedly permanent **state** is an unwarranted reduction of the system's concept itself: any **structure** offers a double **synchronic** and **diachronic** character, which corresponds with the various aspects of a functional **process**.

1728

INTEGRATION (Levels of)^{1) - 2) - 4)}

The different **hierarchic levels** at which a system can be viewed.

Integration of **perception**, **understanding** or **organization** is, at its best when structured in **hierarchic levels** (without authoritarian connotations).

The perceiver or **decider** acting globally must disregard many details, as irrelevant for a comprehensive **synthesis**, in order to acquire a general **understanding** of the system and be able to manage it.

However **perception**, **understanding** or **management** must be translated into specific and practical **action** at different **levels**, from wide-reaching to minute and local **operation**.

At each **level**, there is a specific **mode** of **action** and, while the active **agent** must be specialized, she/he must also have sufficient notions about what is going on at the wider or narrower **level** and of his or her place in the global **set**.

1729

INTEGRATION (Social)^{1) - 4)}

According to G. SOMMERHOFF social integration results from the existence of **directive correlations** between individuals. He writes: "Complex **patterns** of **directive correlations** may exist not only between an **organism** and its **environment**, but also between members of an **aggregate** of individual **organisms**... they can impart a measure of organic integration and unity to such an **aggregate**" (1969, p.190).

If the existence of **directive correlations** is permanent and "... if one of the ultimate **goals** of these **directive correlation** systems is to preserve the continued existence of the social **aggregate** for its own sake, the **aggregate** itself may come to function as a biological unit in a way formally not unlike that of a single **organism**" (ibid).

SOMMERHOFF adds: "A social **aggregate** as a **colony** of insects is not a physical unit in the above sense (*i.e. in the sense of an organism*), but it can still be a biological unit in the same sense as above. Provided there is **communication** between its members, the physical prerequisites are satisfied that enable the **activities** of one member to become **functions** of the **activities** of the others" (ibid).

Translevel isomorphies described by J.G. MILLER from the **cell** to the social planetary **levels** finds here a very basic explanation. One

may also anticipate the possibility of a general theory of **associativity**, or **sociality**, whatever the nature of social **components** may be.

Another interesting connexion can be made with W.R. ASHBY's **Markovian matrixes** of statistical individual and collective **behaviors** of animal species.

Finally, the very recent **emergence** of collaborating **automata** seems to announce the possibility of future **automata** societies endowed with distributed abilities, able to organize themselves in a collective way by **directive correlations** in order to execute complex tasks in common.

1730

INTEGRATION (Vertical) ²⁾

The existence of various **hierarchic levels** of integration in a system.

As the system differentiates during its period of **growth**, it tends to need more and more varied **resources**, which must be extracted from its **environment**.

M. J. SIRGY and R. H. GILES Jr. state: "Large **organizations** usually strive to become vertically integrated (i.e. "intrabiotic") to insure **control** over **environmental resources**" (1986, p.239).

More varied **inputs** imply more diversified **subsystems** to transform and assimilate them and for elaboration of the resulting products.

More **diversity** means at the same time more **interactions** and more internal **conflicts**. Thus the need for **regulation** and **control** increases and, even, some meta-controls appear and with them a **hierarchy** of **structures** for **governance** of the system.

1731

INTEGRATION vs ISOLATION ¹⁾

More than contradictory or incompatible, integration and isolation seem somehow complementary forces.

J. T. BONNER writes: "It is an interesting paradox that at all **levels** of **complexity** there seem to be forces which bring **components** together, as in integration of **cells** into individual **organisms**, or gatherings of **organisms** into social **groups**; but at the same time there are other forces which work in the opposite direction and cause those individual **organisms** or those social **groups** to be isolated from one another. Curiously, the forces which seem to be working in opposite directions producing integration and isolation are the same; they are forces of natural **selection**" (1988, p.229).

In order to be able to establish *well defined interconnections*, based on reciprocal **constraints**, the **components** of any system must be separated from each others, but not to the point that **relationships** could never become

established. BONNER describes the different biological and ethological **mechanisms** which allow for these antithetic **processes**. For a good example, see "**Dictyostelium discoideum**".

1732

INTEGRATIVE TENDENCIES ¹⁾

"The characteristics related to the manner in which **holons** are **part** of larger **wholes**" (T.F.H ALLEN & T.B. STARR, 1982, p.270).

ALLEN and STARR comment: "These characteristics reflect the acceptance by the **holon** of the **constraints** placed upon it by more inclusive **holons**" (p.270).

1733

INTEGRITY (Systemic) ²⁾⁴⁾

"The degree of **congruence** between the stated (espoused) principles of **order** (e.g. **model** or *Weltanschauung*) and the principles of **order** by which the system actually operates" (Fuschl Conversation May 2000 on "Social awareness")

This notion is related to socio-cultural and political systems. When systemic integrity is low, the system is exposed to desintegration or at least deep and possibly traumatic **transformations**.

1734

INTELLIGENCE ^{1) - 3)}

"The apprehension of the relevant **structure** of the total **behavioral field**" (R.L. ACKOFF & F.E. EMERY, 1972, p.52).

ACKOFF and EMERY define "**relevance**" "...in terms of the immediate and presumptive future **purposes** of the actor" (Ibid).

This definition also fits, partly at least, **Artificial Intelligence**, as for example in chess **programs**.

According to W.R. ASHBY: "... the test of intelligence is the power of appropriate **selection**... As a result every intelligent system is subject to the following postulate: Any system that achieves appropriate **selection** (to a degree better than **chance**) does so as a consequence of **information** received" (1963, p.215).

However this does not seem to be enough.

The system must be able to **process** such obtained **information** in a satisfactory way. And if it does that, the problem of **understanding** how it acquired such capacity remains still open. ASHBY states that this results of some form of "preprogramming", which according to him, has been acquired by "five billion years of evolutionary molding all occurring in three-dimensional **space**" (p.216) and subsequent **learning**, within this pre-existing **frame**.

It is anyhow quite difficult to understand what intelligence really is without a deeper **understanding** of the devices that produce it: namely the **brain** and possibly the computer

(parallel or sequential? Hardware plus software, plus user ?). In ASHBY's words: "The living **brain** has had only one problem throughout **evolution**: how to get the necessary **information** in and how to **process** it with a reasonable **efficiency**" (p.217).

And now, we have the problem to explain how it did it. This is where the **connection machine** and other similar devices could possibly help us.

1735

INTELLIGENCE AMPLIFICATION ²⁾

"A **process** by which the power of appropriate **selection** is increased beyond the intelligence of the system which **controls** that **process**" (K. KRIPPENDORFF, 1986, p.40).

KRIPPENDORFF, taking as an example a computer programmed to play chess, writes: "... if that computer is programmed to compute more alternatives, recalls successes and failures with increasing perfection and makes better and faster **decisions** than its programmer could make, then it exceeds or will soon exceed that programmer's manifest ability to make informed **decisions**" (Ibid).

Thus, intelligence amplification is conditioned by **rules**, and meta-**rules**, which are used to understand **inputs**, select and perfect **responses**, and possibly invent some new ones.

1736

INTELLIGENCE (Distributed ARTIFICIAL) ⁵⁾

A technique leading to "...the construction of so-called multi-**agents** systems which permit modelization of the **behavior** of a **set** of more or less expert entities, more or less organized along kinds of social **laws**" (J. ERCEAU & J. FERBER, 1991, p.751).

ERCEAU and FERBER explain that "These entities or **agents** are endowed with a measure of **autonomy** and are immersed in an **environment** wherein and with which they interact. Accordingly, their **structure** is organized along three basic **functions**: to perceive, to decide and to act. They are physical entities (**sensors**, **processors**, vehicles...) or abstract ones (tasks to be executed, displacements,...), able to act upon their **environment** and upon themselves, i.e. to modify their own **behavior**. To do this they are endowed with a sketchy **representation** of that **environment**, and with perceptual and **communication** abilities" (Ibid).

The striking likeness of D.A.I.'s basic concepts with the basic working conditions of human societies may well be a harbinger of the shaping of societies of cooperative **automata**.

According to the authors the characteristics of these **automata** are of two different kinds. They should include:

- "eco-behavior" programs as for example satisfaction of needs, escape, aggression, return to satisfaction which would allow them to "... better their individual and community performance through learning-like mechanisms".
- specialized modules within the structure of every agent. We should thus have "communicating agents, rational ones, intentional ones and reactive ones" (Ibid).

1737

INTELLIGENCE (Distributed ARTIFICIAL)⁵⁾**Structure of the agents**

J. ERCEAU and J. FERBER distinguish and characterize in the following way the agents in D.A.I.:

Reactive agents: "They are of the lowest class. They only have at their disposal a reduced protocol and communication language and... their capabilities correspond merely to a stimulus-action law. The class of reactive agents include various levels, according to their capacity to gather and produce global behavior".

Communicating agents: "... which have at their disposal a complete communication protocol, but whose conversational and behavioral sections are mutually dependent ... The agents, at that level are unable to process such informations which are off the limits of their expertise domain" and thus "... the exchanges of informations are closely tied to the expertise existing within their domain".

Relational agents: "Each agent has at his disposal precise abilities, beliefs and a partial representation of its environment, including the other agents in the system. Task allocations mechanisms are incorporated for specific practical applications".

Intentional agents: They constitute the upper level: "Each of them is endowed with specific goals, partial plans allowing it to reach its goals, with intentions and beliefs, and the possibility to contract commitments which it must carry out, or contract other agents to perform some actions" (1991, p.757-8).

1738

INTELLIGENCE: Natural and Artificial^{1) - 3)}

To put this very general definition by ÖREN in perspective, let us quote R. FISCHER: "The most important is that the brain is self-determined, and cannot be programmed, without the consent of its Supervisor-Ego" (1992).

Leaving aside this last conceptual crutch, the self-determining brain can be understood as self-organizing, in terms of MATURANA, VARELA or VENDRYES' autonomy. Conversely, artificial intelligence in its classic sense, is not self-organizing. This could however not be any more true for future connection machines, constructed as parallel working networks.

ÖREN, having thus defined intelligence in very general terms, elaborates in the following way:

"... an advanced knowledge-processing ability implies the intelligence of an entity to be an ability:

- 1) for the representation of knowledge about itself and/or about some other entities;
- 2) for the generation, transformation, organization, location, selection, evaluation and analysis of different types of knowledge, as well as
- 3) for communication. The ability for communication requires the ability to answer and ask questions in a language (computer or natural language, including a spoken language) and includes abilities for perception, sensation, elicitation, acquisition, assimilation and dissemination of knowledge.

"Being an adaptive knowledge processing ability, implies that the intelligence of an entity is an ability for changing its environment or itself. The latter implies that intelligence is an ability:

- 1) for learning, which in turn implies abilities for generalization, abstraction and specialization of knowledge, and
- 2) for mutation, i.e. generation of self-modified versions of itself.

"Being a goal-directed knowledge-processing ability implies the intelligence to be an ability for:

- 1) goal setting
- 2) goal processing (including subgoal, goal modification, goal ranking, goal selection), and
- 3) goal-directed knowledge-processing (including goal-directed representation, generation, transformation, organization, location, selection, evaluation, and analysis of knowledge as well as communication and adaptation).

"A definition of artificial intelligence can then be: "The science and technology of knowledge processing using software that has goal-directed, adaptive, and other advanced knowledge-processing abilities. The aim of artificial intelligence can then be:

- 1) to find out about the nature of device-independent intelligence, and
- 2) to build intelligent machines (i.e. intelligent computers and intelligent computer-embedded machines) via advanced software" (p.5/6).

There remain, of course, lots of question-marks; for example:

- What is precisely knowledge, compared for example with stored data, information, or wisdom?
- How are goals formed? If a machine becomes able to form goals, what would be the interrelations between natural and artificial intelligent beings?

- To which extent is intelligence (natural or artificial) algorithmic after the necessary learning process?
- What does precisely self-modification mean?

1739

INTELLIGENCE (Swarm)

→ Swarm

1740

INTENTION³⁾

"The conscious will to reach a goal or to perform an action" (J. ERCEAU & J. FERBER, 1991, p.753).

ERCEAU and FERBER, who discuss this concept in relation to multi-agents robots systems, explain that reciprocal communication of intentions between participants of a network is an absolute necessity since: "Agents must be able to acquire informations about their environment and each other, either directly by their own perceptive devices, or by exchange of informations or, still, by learning" (p.754).

A theory of intentions has been derived by J.J. AUSTIN and R. SEARLE from their former theory of language acts established in the sixties.

1741

INTENTIONALITY¹⁾³⁾⁵⁾

"Goal-seeking directness toward the outer world" (C. EMMECHE, 1994, p.122)

This author comments: "This attention, a requirement for moving around in our living environment, can also be found among other organisms with well developed nervous systems" (Ibid).

The american neurologist W.J. FREEMAN has researched the neurodynamics of intentionality in animal brains, which he considers as the basis for intelligent behavior.

The first stage in the process is observation, whose cerebral effects can be seen through the use of electro-encephalograms. Even in the simple brains of salamanders, for instance, "the simplest actions, such as searching for food or evading predators, requires an animal to know where it is with respect to its world, where its prey or refuge is, and what its spatial and temporal progress is during sequences of attack or escape" (1998, p.4).

FREEMAN states that the limbic system (a relatively archaic part of the central nervous system) is the organ of intentional behavior: "... the necessary and sufficient part of the vertebrate brain to sustain animal intentional behavior is the ventral forebrain, including those components that comprise the external shell of the phylogenetically oldest part of the forebrain, the paleocortex, and the deeper lying nuclei with which the cortex is connected. These components suffice to support remarkably

adept **patterns** of intentional behavior in dogs, after the newer parts of the forebrain have been surgically removed... and in rats with neocortex chemically inactivated... "(Ibid).

A similar **concept** was developed earlier by the French philosopher M. MERLEAU PONTY, as "perceptive intentionality" (1945).

It has also taken a psychological meaning, whose multiple shades are not altogether very clear, as announced intentions do not always correspond to hidden ones, while the difference is difficult to fathom. Systemic psychology has still a long way to go!

It seems also to be somehow complementary to J.J. GIBSON's **affordance** (1986).

→ **Brain (Triune)**

1742

INTERACTION ¹⁾ - 2)

Any exchange between **elements**, **subsystems** or systems.

A. BAHM explains the concept of interaction within a system (an existing system in his terms, i.e. **concrete** or real, opposed to constructed systems, which are mental and cultural **models**):

"**Interaction**: The **whole** and **parts** of each existing system interact. That is, they act upon and influence each other (casually or conditionally) in ways that constitute it and maintain it:

"(1) Interaction involves **action** and **action** involves **change**. Each existing system changes. Existence itself involves existing or remaining through changing times, so every existing system involves **changes**, at least "changing times". A system may be involved in many kinds of **changes**, e.g. (a) **changes** within its **parts** (when a **part** changes internally it causes the **whole** to be a **whole** with a part changed internally); (b) **changes** between **parts** (becoming more like or unlike, more or less interactive); (c) loss of a **part** or **parts**, addition of a new **part** or **parts**, exchange of a **part** or **parts**; (d) **changes** in the **whole** (as more or less unitive, more or less strongly uniting its **parts**, or as a **whole** or more or fewer **parts**); and (e) **changes** in the **interrelations** of **whole** and **parts** (etc., more below).

"(2) Interaction involves permanence. Each existing system endures or remains the same from its beginning to its end. To be permanent is to remain through **change**. Interaction of **whole** and **parts** involves the **whole** remaining the same while it is acting on its **parts** (each **part** and all of its **parts**) and while it is acted upon by its **parts** (by each **part** and all of its **parts**). Interaction involves the **parts** remaining the same while acting on the **whole** and being acted upon by the **whole**. Interaction involves **interrelations** and **interdependence** of **whole** and **parts** remaining the same.

"(3) Interaction thus involves both **change** and permanence. Permanence and **change** involve each other because to be permanent is to endure or to remain through **change** and **change** can continue to be a **change** only by enduring or remaining a **change**. Both permanence and **change** may be variable, some systems existing for a shortest instant and some for a longest duration, and some characterized more by permanence and some more by **change**" (1986, p.178-9).

This kind of verbal fireworks, apparently somewhat paradoxical, becomes very meaningful when considered from the viewpoint of **autopoiesis** and **organizational closure**, which sustains that the **set** of internal interactions within the system is what defines which interactions it can operate with its **environment** and which not. These internal interactions lead to **cyclical** or **hypercyclical self-reproduction** of the system. Thus it maintains its permanence *thanks to change*.

On the other hand, interactions among individuals, i.e. elemental systems, as for example in ants **colonies**, are the driving force of communal **self-organization**, i.e. **sociality**. Interactions create at an **emergent level**, more complex units, endowed with new properties, simultaneously limiting and expanding the scope of individual activities.

The complete **set** of possible **interactions** within a system, when not too intricate, can generally be represented by a **Markovian matrix**. This idea has been adapted to sociology by W. BUCKLEY as the "interactions matrix" between individuals and small **groups**.

1743

INTERACTION DENSITY GRADIENT ²⁾

T.F.H. ALLEN and T.B. STARR explain: "At each point in **space** there is a certain **rate** of exchange of **information** or **matter** associated with a particular form of **signal**. At successive points in **space** there may be a **change** in the quantity of passing **signal**. Monotonic **change** in the amount of **signal** passing successive points constitutes an **interaction density gradient**. At surfaces, **interaction density gradients** are particularly steep" (1982, p.270).

1744

INTERACTIVE MANAGEMENT

→ **Management (Interactive)**

1745

INTERACTIVE PLANNING

→ **Planning (Interactive)**

1746

INTERCONNECTEDNESS ¹⁾

As the prefix "inter" implies **relationships** among **elements**, the term "interconnectedness" seems unnecessary **redundant**.

→ **Connection; Connectedness**

1747

INTERDEPENDENCE ¹⁾²⁾⁴⁾

1) The condition of **elements**, **subsystems** or systems which need of their **interactions** to maintain themselves.

A **whole** and its **parts** are also interdependent.

Considering that any **concrete system** depends on a specific **environment** and is related to other **concrete systems**, it can be seen that the notion of interdependence is fundamental in systems **hierarchies**, and as a base of the **concept** of **meta-** (or **supra-**) **system**.

2) A **situation** within such as a "**change** in one **component** brings about **changes** in others" (B. BANATHY, 1973, p.87).

Interdependence is instrumental for **autopoiesis**, a systemic **process** in which it is very strongly reciprocal and leads to a closed **cycle** of **reproduction** of the **components**, specific to the system.

3) **Relation** by which the existence of two or more **parts** is reciprocally conditioned by these **parts**.

J.C. LUGAN proposes a classification of different types of interdependences: "**linear**, **circular**, **dynamic**, **cybernetic**, **dialectic**, **contradictory**" (1993, p.117).

Interdependence is a characteristic of **complex systems** as opposed to **composite systems**, whose **elements** remain independent from each other (i.e. interdependent at most in a collective statistical way).

It increases in relation to the number and the types of **interrelations** between the **parts** and signals a growing **integration** and **heterogeneity** of the system.

Interdependence is also a basic relation *between* systems (and **groups** of systems) when significant **outputs** of the ones become **inputs** for the others, and reciprocally. Such a **situation** leads to reciprocal **regulation** and eventually to **integration** within a more global system. In such case, a new internal **organization** supersedes former intersystemic **relations** and we are back to **organizational closure** and **autopoiesis**.

Interdependence is a very basic feature in systems, starting with their very **emergence** from formerly unrelated **elements**.

Such a **relationship** implies **continuous** or **intermittent** functional **interactions** between the **elements**.

Reciprocity of the **interactions** tends to derive toward different possible **situations**:

- one **element** may manage the other or others in a simple hierarchical way, either through a natural **regulation** or by the use of a controlling **artefact**.
- one element may react to some **action** of the other through a **feedback**, that can be reiterative or merely occasional, and also be triggered only if some **critical value** is attained
- when the **interactions** become generalized and more or less permanent, the elements may tend to become **part** of a system of higher **level**
- different kinds of **associations** become possible, from still more or less loose intermittent connection to **commensalism**, **symbiosis** or **parasitism**.

Interdependence role is obvious at all **levels** of nature's **organization**, from subnuclear physics to the **man-planet system** presently in the making.

1748

INTERDEPENDENCE (Asymmetrical) ²⁾

The interdependence of upper and lower **strata** in a **hierarchized system**.

M. MESAROVIC et al state: "The requirements for proper functioning of a system on any **stratum** appear as conditions or **constraints** on the **operations** of the lower **strata**", and "... for a proper functioning of the system on a given **stratum**, all the lower **strata** have to function correctly" (1970, p.41).

1749

INTERDEPENDENCE (Declaration of) ^{1) - 4)}

Admitting reciprocal **dependence** in **organizations** and **social systems** is one basic condition to maintain their **coherence** and **efficiency**, as well as the individual physical and psychological well-being of their members and their good social **integration**.

A first "Declaration of interdependence" elaborated by the workers of the City of Portland Bureau of Maintenance is reproduced in G. and E. PINCHOT's work about the rise of the "intelligent **organization**" (1993, p.238).

The subject has been taken up by the **Fuschi Group** (1996) and will probably become a very important part of a systemic social science.

It is also related to the concept of **heterarchical organization**.

1750

INTERDISCIPLINARITY ^{1) - 3)}

An integrative **relationship** between two disciplines (Ch. FRANÇOIS, 1993, p.114)

Interdisciplinarity is less embracing than **multi-disciplinarity** and should not be confused with systemic **transdisciplinarity**.

According to Ch. FRANÇOIS: "Interdisciplinarity should be used only to describe a specific **interrelation** between two disciplines, as for example biochemistry, astrophysics or population genetics. This does not present many difficulties. It implies generally the bridging between two disciplines, since one needs of the other, or one brings new insights to the other. Any interdiscipline tends to become a discipline by its own right and supposes an excellent **knowledge** of both intervening **fields** and in many cases, of some mathematical **models** used as a lingua franca" (Ibid).

J.G. MILLER states: "The more general a scientific law is, the more powerful it can be because it applies to a larger class of **phenomena**. It is important, therefore, that there be more scientific effort devoted to testing a wide range of **cross-level hypotheses**. After all, the most recalcitrant problems now facing societies are not limited to single disciplines or single **levels**. Resolution of **environmental** problems, for example, often depends on **knowledge** derived from biology, the earth sciences, chemistry, biochemistry, engineering, economics, other social sciences, and the law. Increasingly, teams composed of experts in a number of **fields** work together.

"One difficulty that arises in so called interdisciplinary **cooperation** (in fact **multidisciplinary**) is the use of different terms, units, and dimensions, some of them applied only to a particular special **field**. The relationships among them are often unclear and it is difficult to translate them so that people who are not specialists in that **field** will understand them. One solution to this dilemma is to attempt to use the dimensions of the natural sciences as neutral reference points to which all other dimensions can be precisely related.

"It is helpful, also, to use neutral terms to recognize similarities that exist in systems of different types and **levels**. These should be as acceptable as possible when applied at all **levels** and to all types of **living systems**. For example, "sense organ" is one term for the **component** that brings **information** into a system at the **level** of the **organism**, but "input **transducer**" is also satisfactory, and it is a more acceptable term to engineers and at the society **level** (e.g. a diplomat or foreign correspondent). Such usage may irritate some specialists used to the traditional terminology of their **fields**. A **language** that intentionally uses words that are acceptable in other **fields** is, of necessity, not the jargon of the specialty. *Whoever uses it may be suspected of not being informed about the specialty*. The specialist **languages**, however, limit the horizons of thought to the borders of the disciplines. They mask important intertype and **interlevel** generalities" (1986, p.76).

Thus, for MILLER, even interdisciplinary cooperation needs a **meta-language**.

This does not however seems to be enough to save simple interdisciplinarity from its narrow limits. In D. McNEIL's words: "... we can be certain that our work will fail if it is not... centered around generality rather than "interdisciplinary" or any other arbitrary juxtaposition of particulars" (1993a).

Synthetically, a new **language** of general character, understandable by everybody, is urgently needed in order to put an end to disciplinary deafness, to "babelization" of the scientific community and to hermetic **compartmentation** between scientific and social actors.

This is particularly true in **management** sciences, as expressed by P. CHECKLAND: "What we need is not interdisciplinary teams but **transdisciplinary** concepts, concepts which serve to unify **knowledge** by being applicable in areas which cut across the trenches which mark traditional academic **boundaries**" (1976, p.127).

1751

INTERFACE ²⁾

A **region** of contact between the **boundaries** of two systems.

The concept is less rigid than the one of frontier or **boundary**, of more common use. The word evokes exchange, more than a more or less hermetic closeness.

J.L. TABARY, for example, bases his evaluation of interfaces on the study of biological **membranes**, which are "permeability barriers" in a selective way: **filters**, **osmose**.

This is indeed the case of any **boundary**.

Later on, TABARY developed as follows the **concept** of interface:

"...the interface **structure**, which concretely ensures the **subject/object** relation, is the stable and permanent **element** all along the **evolution** of the **subject** and the construction of a **phenomenal** reality. The constitutive properties of the interface overrule all the relations of the **subject** with its **environment**.

"There is a primeval **subject**, endowed with a minimum of **autonomy**, pre-existent to any encounter with the **environment**. However this **subject** does not practically know anything from itself and from its **environment** and must construct nearly from scratch its **knowledge** from itself and from reality.

"...

"An **autonomous system** cannot be **closed**, nor freely **open**: its relations with its **environment** require interfaces... It may not be freely open, otherwise it would be quickly destroyed.

"...The only solution is the controlled opening. There are of course permanent exchange **flows** between the inside of the system and its **environment**, but **autonomy** can be protected only if a strict **control** of these exchanges is maintained." (1991, p.171).

TABARY distinguishes two complementary types of interfaces:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"a) **the receptive interface** includes a **receptor** site at the external face of the **structure** which guarantees **closure** (cellular **membrane** for example) and an **effector** site on the internal face. The presence of a specific **agent** on the **receptor** site triggers a switch from a **state 0** to a **state 1**. This topple over is transmitted to the **effector** switch, which in turn switches and modifies some underlying **cyclical reaction**. Two essential features must be taken into account:

"The interface **response** is identical, whatever be the external stimulating **agent**. From the inside of the system no **input** can be qualified and only the monotonous switch of the **effector** site is known ("it is able to say how much, it cannot say "what" – von FOERSTER).

"The interface particularities remain absolutely stable during the whole life and the cognitive development" (TABARY, *ibid*).

The basic role of the receptive interface is thus to operate the **selection** and the **transduction** of the **inputs** for the use of the system. The role of the **effector** interface is opposite, as explained by J.C. TABARY:

"b) **The effector interface** includes a **receptor** site at the internal face of the **structure**, which guarantees **closure** and an **effector** site on the external face. The arrival of a specific **agent** (for example, a synaptic mediator) on the **receptor** site **triggers** a switch of the **receptor** site from a **state 0** to a **state 1**. This topple over is transmitted to the **effector** site, which in turn switches and this modifies the global **configuration** of the system, causing an **output** toward the **environment**" (p.173).

It should be interesting to try a generalization of these concepts in the cases of complex **social systems** (firms, **organizations**) and cultural ones.

1752

INTER-INFLUENCES ¹⁾⁽²⁾⁽⁴⁾

C. HARDY uses the concept of inter-influences between **elements** and **processes** as a general key to **self-organization** (1998)

Inter-influences do not only concern **interactions**, nor even recurrent **feedbacks** between elements.

In fact, inter-influences can never be perfectly described, and still less perfectly understood.

Multiples inter-influences are a basic characteristic of **networks** of all kinds. But they must be considered in relation to the **space** and **time** features of the network. Space is never really **isotropic** from the viewpoint of **propagation of effects**.

From the same viewpoint, no propagation is ever instantaneous and, moreover, the velocities are not **isochronous** and **time lags** fragment the general **determinism** of the network and may introduce a certain measure of **chaos**.

This partly explains the special type of **self-organization** known as **self-organized criticality**.

1753

INTERMITTENCE ¹⁾

The characteristic of a **phenomenon** or **process** which stops and starts by spurts at intervals.

The **behavior** of systems thus affected is dependent of the **recurrence** at **long time scale** of very important or massive **events** or **conjunction** of events. An example is the recurrence of glacial **periods** in Earth climate (see GOLDENFELD and KADANOFF, 1999, p. 87)

M. FARGE explains: "Spatio-temporal intermittence is linked to **distribution in space** of coherent **structures** and to **distribution in time** of the moments they connect and thus undergo strong **interactions**" (1992, p.240).

Other examples are volcanic eruptions, big earthquakes, crashes in stock markets, **epidemics in populations**, hurricanes in the Caribbean zone, typhoons and "El Niño" **events** in the Pacific Ocean. Intermittence generally implies sudden paroxystic **changes** or an epochal reversal in-between variable but long **relaxation periods**. It is related to **synergetic processes**, **power laws**, and **dissipative structuration**, all of these probably governed by great **fluctuations of energy inputs**, or their **cumulative long term effects** (*ibid*, p.87-89).

Intermittence is in some sense the manifestation of a kind of **memory** in a system that sometimes seems to behave randomly.

Intermittence is in many case a signature of **chaos**.

P. BERGE and M. DUBOIS state: "The characteristic **behavior** of intermittences is that of a **signal**, regular - **periodic** or **quasi-periodic** – during a certain **time span** and evolves to give during a brief instant a chaotic "puff": it then turns back to its regular **behavior** and the **process** starts again.

In this case the **chaotic behavior** is defined not only by the "puffs" but still more by the **random distribution** of the regular **period lengths**" (1992, p.150).

The **observation** of intermittences as tracers of probable **deterministic chaotic behavior** could possibly be useful for the study of many ecological, economic, historical and social **situations** and systems.

→ **Numbers (Prime); Periodicity; Term (short-, medium-, long-)**

1754

INTERNAL TRANSDUCER ^{1) - 2)}

"The sensory **subsystem** which receives, from **subsystems** or **components** within the system, **markers** bearing **information** about significant alterations in those **subsystems** or

components, changing them to other **matter-energy forms** of a sort which can be transmitted within it" (J.G. MILLER, 1978, p.3).

This is one of MILLER's **critical subsystems** in his **taxonomy of the 20 critical subsystems** in systems.

1755

INTERNALIZATION ^{3) - 4)}

"A **learning process** whereby the **components** or **subsystems** of a system acquire a **meta-system** that represents the requirements, **controls**, **goals**, **values** and **purposes** of that system and thereby relieves that system of some of its original **regulatory** and **control burdens**" (K. KRIPPENDORFF, 1986, p.41).

Internalization is of course a process proper to individuals in **human social systems**. It should be interesting to explore the possible existence of similar or equivalent **mechanisms** in animal societies and in biological systems.

1756

INTERNATIONAL ASSOCIATION for CYBERNETICS ¹⁾

This Association was founded in 1956 in Namur (Belgium) by a group of Cybernetists (J. DIEBOLD, N. WIENER, L. COUFFIGNAL, W. GREY WALTER, G. PASK, etc...). It received the sponsorship and material help from the Namur Province since its beginning. Its first President was a noted Belgian cybernetist, Prof. G. BOU-LANGER.

ST. BEER, H.von FOERSTER, W. ROSS ASHBY, H. FRANK and R. VALLÉE were also among the early members and collaborators of BOU-LANGER.

The Association organized a triennial Congress of Cybernetics in Namur since 1956. The 14th, and last to date, took place in 1995. The Association also published the quarterly journal "Cybernetica" since 1958, whose collection is one of the most valuable sources on cybernetics.

In the recent years, a stronger connection between cybernetics and systemics can be observed.

It should also be noted that, under the leadership of H. FRANK, the "Internacia Lingvo", better known as "Esperanto" was recognized as an official language in the Congresses, along with English and French.

Footnote: Unfortunately the I.A.C. has been dissolved in year 2000, due to the suppression of funding by the Belgian Province of Namur.

"Cybernetica", the 41 year old Journal of the Association, published its last issue (2/4, 1998) in 1999. Its suppression is a considerable loss for cybernetics

1757

INTERNATIONAL FEDERATION FOR SYSTEMS RESEARCH (IFSR)¹⁾

The Federation is the **organism** which coordinates the action of the international and national systems and cybernetic societies.

It was founded in 1976 by the following societies:

- The American "Society for General Systems Research" (Now "**International Society for Systems Science**").
- The "**Austrian Society for Cybernetics**" (Österreichische Studiengesellschaft für Kybernetik, Schottengasse 3, A 1010 Wien – Österreich)
- The "Dutch Systems Group" (**Systeem Groep Nederland** – University of Amsterdam – Groot Bickerstraat, Amsterdam – Nederland)

The Federation has presently nearly 30 member societies, African, Asian, European, North and South American.

Its seat is in Austria, thanks to the kind help of the Austrian Government. Its Secretariat is at Linz University, presently managed by Prof. Eng. G. CHROUST.

It publishes a quarterly Newsletter, featuring announcements of meetings and conferences, reports on the same, bibliographies, comments and general news.

Its official Journal is "Systems Research" (Ed. M. JACKSON).

It also sponsors the Fuschl meetings.

Its President and other authorities are elected for 3 -years terms.

For frequent updates and complementary information (in particular about member societies) please contact Prof. Gerhard Chroust: gc@sea.uni-linz.ac.at, or IFSR web site: <http://www.ifsr.org>

Prof. Yong Pil Rhee was the next President, succeeded in turn by Prof. Michael Jackson and Prof. Jifa GU.

1758

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS (IIASA)¹⁾

M.C. JACKSON describes IIASA as follows: "In 1972 the International Institute for Applied Systems Analysis (IIASA), a nongovernmental **interdisciplinary** research institution, was set up in Laxenburg (Austria), on the initiative of the academies of science (or equivalent institutions) of 12 nations. This Institute has been seeking to apply RAND-style **systems analysis** to major world **problems** related to, for example, **energy**, food supply and the **environment**... "According to the IIASA "handbooks", **Systems Analysis** aims to help public and private **decision makers** to resolve **problems** arising in **complex sociotechnical systems**.

"It brings to bear the tools of modern science and technology, searching for regularities in **system behavior** and to provide evidence about the **costs**, benefits, and other consequences of various possible **responses** to the **problem** at hand..."

"The **methodology of systems analysis** can be seen as consisting of seven major steps, as follows:

- Formulating the **problem**
- Identifying, designing and screening alternative **responses**
- Building and using **models** for predicting the consequences of adopting particular **responses**
- Comparing and ranking alternative **responses**
- Evaluating the analysis
- **Decision** and implementation
- Evaluating the outcome" (1992, p.76).

This **methodology** seems to have been oriented basically to technical systems **planning**, without participation of many **stakeholders** (notably people personally interested in the issues and politicians).

As a result, and very unfortunately, IIASA studies had scant impact on concrete complex **issues** from 1972 on.

1759

INTERNATIONAL SOCIETY FOR THE SYSTEMS SCIENCES¹⁾

Formerly: "Society for General Systems Research".

This was the original Society, created in 1956 in the U.S. by the founders: L.von BERTALANFFY, K. BOULDING, A. RAPOPORT and other scientists of various disciplines.

It has presently national divisions in Asia, Australia, Europe and North and South America, as well as a number of chapters in various states of the U.S., all represented in the ISSS Council. The Society has a number of Special Interest Groups (S.I.G.s) interested in specific uses of Systems concepts and **models**, as for example Law, Systems **Epistemology**, Climate change, Psychology, **Informatics**, etc... It publishes a quarterly "General Systems Bulletin" with announcements, comments, membership information, reviews and directories. It has also published annually for 28 years an important "General Systems Yearbook", with valuable collections of papers. (suspended since 1985).

It organizes a yearly meeting with numerous systemists who present and discuss their ideas.

The Society sponsors some of the main journals in the field:

- International Journal of General Systems (Ed. G. KLIR)
- Systems Research (Ed. M. JACKSON) fused 1997
- Behavioral Science (Ed. J.G. MILLER) fused 1997

1760

INTERNATIONAL SYSTEMS INSTITUTE¹⁾

This Institute was created in 1980 in San Francisco by B. BANATHY and other Californian systemists. Its seat is now in Carmel, CA. "It is organized as a **community** of scholars and practitioners and a **network** of institutions. It aims to apply systems and **design** thinking to:

1. create **models** and **methods** for the **design** of educational and other **human activity systems** and
2. to design and develop **resources** for systems and **design learning**" (as quoted from ISI folder).

ISI organizes international "conversations" that "provide opportunities for professional development in systems and **design** applications" (Ibid).

Its program "is carried out by Institute Fellows who pursue the work of ISI in their own **organizations** as well as in several ISI programs areas and research teams". (Ibid) ISI Fellows are from 20 different countries.

ISI has recently created a "Transnational Council" aiming at diminishing **transcultural** misunderstandings and **conflicts**. It is an active member of IFSR.

1761

INTERCEPTION²⁾

Self **perception** by a system of its own **involvement**.

In order to maintain itself a system must be able to maintain its **dynamic stability**, which is possible only if it has a sufficient **control** over its internal **state** and remains **autopoietic**. Well integrated systems possess a number of devices which allow them to exercise the needed **controls** or **regulations**, by some kinds of internal "**knowledge**".

In biological systems such a "**knowledge**" does not necessarily reaches the **level** of **consciousness**.

This seems to be also the case in **social systems**, at least in a collective sense, since in some cases, individuals duly perceive some abnormal internal **state** but are not able to awake the global attention of the **group**. This could be called the "Cassandra syndrome".

→ **Adaptability; General adaptation syndrome; Leveling mechanisms**

1762

INTERPENETRATION²⁾

Reciprocal influence between the internal characteristics proper to a given system and those resulting from its exchanges with other systems.

According to N. LUHMANN systems enhance their **complexity** by interpenetration without however merging. (see W. KARGL, 1991, p.582).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1763

INTERPLAY→ **Interaction; Networking**

1764

INTERPOLATION²⁾

The determination of a **value** in a **function** intermediate between known **values**, using some procedure or **algorithm**.

The soundness of interpolations depend on the soundness of the procedure, because the regularity or **continuity** of the **function** may not be secure.

This in turn reflects the possibility that the modeled **process** may present unsuspected and irregular **variations** in the unexplored intervals.

Interpolations suppose a well established **determinism** of some kind and are thus very risky in **processes** that could be **chaotic** under a **deterministic** appearance.

1765

INTERPRETIVE STRUCTURAL MODELING^{2) - 4)}

A **methodology** that "provides the means to formulate a **pattern** or **structure** of **elements** associated with **issues** formulation" (J. WARFIELD, 1994b, p.219).

WARFIELD who introduced ISM, adds: "The **elements** may include **needs**, **constraints**, **objectives**, or options in a variety of fields such as **education**, public facility **planning**, city budget-cutting, or **system design**.

"This method is useful when a **complex issue** is under study, and there are **interactions** among the diverse **elements** of the **issue**. A focused **group** discussion on the **issue** is needed on the way to the development of one or more **relationships maps**.

"The **relationship** used in structuring must be transitive, and should be carefully chosen to arrive at the most useful outcome for purposes of interpretation. The **elements** that are structured as well as the **relationships** used to structure them are clarified by reasoning and discussion stimulated by the **process**. The quality of the results obtained depend upon skilled **process** leadership, which must be facilitative rather than **issue-involved**...

"The use of ISM produces one or more documented **models** of **elements interrelationships**. Part of the product will include a carefully refined **language** with which to describe or discuss an **issue** or system. There will be a significantly enhanced **understanding** of the **issue**, accompanied by modification and clarification of initially formulated **elements** and **relationships**" (Ibid).

WARFIELD provides a very extensive **description** of the **methodology**, that he also characterizes "...as a collection of **algorithms** designed to facilitate **group interaction**, **learning**, structuring, **representations** of **patterns**, amendments of **structures**, and interpretation of complex **issues**" (1995e).

ISM is an important tool at the beginning of any **process** of **problem** or **issue management**, or **systems design** and a basic feature of **Generic design**.

1766

INTERPRETIVE SYSTEMOLOGY¹⁾³⁾⁴⁾

A set of concepts introduced in Venezuela by H. LOPEZ GARAY and R. FUENMAYOR and applied and developed at the Universidad de los Andes (Mérida, Venezuela)

According to FUENMAYOR, Interpretive Systemology has its roots in the "**self-referential structure** of everyday living **situations**", which provides it with "a **phenomenological ontology**" (1991 a.)

The Mérida School uses Interpretive Systemology basically as a sociological **methodology** and as a tool for the study of typically Venezuelan situations, as seen from a **variety** of thematic interpretive **contexts**", i.e. different **frames** produce different **meanings**. Each of these represents a specific worldview. As an example, businessmen, priests, union leaders, politicians or bureaucrats have all different views about "Public Health Services".

Thus, debates between these various views are finally rooted in different interpretive modes of society, among them:

Social Darwinism: everyone vies for himself. The State has no role to play.

Radical Liberalism: the State must only insure fair competitiveness

Socialized Liberalism (i.e. Welfare state): the State must take care of those who were, or are unable to pay for their own welfare

Socialism: the State owns and manage everything and guarantees all social services to all citizens.

In synthesis Merida's Interpretive Sociology amounts to a systemically and **autopoietically** colored social theory according to which the ways a **social system** is considered is necessarily inscribed within one or another **interpretive model** (generally in a **recursive** style)

Of course all of the four **model's** types are ideological, i.e. biased in some way or another

While Interpretive Systemology takes its distance from all models (but possibly not the same distance from all), it still does not state why all these so varied theories of society need (or should need) an ideological fundamentation, blind of course in each case to itself in a selective way.

What would be needed is a good general theory of **ideologies**, as social and cultural self-generated organizers, including about the way they emerge in specific places and times. Such a theory should include for example the old Chinese mandarin state, or HAN FEI's legistic systems and the Hindu caste system, on the same footing than the North-american variety of capitalism, the Western concept of democracy or the Islamic sharia as basic law.

Of course, Interpretive Systemology could be a step toward this wider goal.

Note: FUENMAYOR's concepts are at least partly grounded in HABERMAS' critique of objectivism. He quotes HABERMAS' critique of HUSSERL: "...While criticizing the objectivist self-understanding of the sciences, HUSSERL succumbs to another objectivism, which was always attached to the traditional concepts of theory" (HABERMAS, 1972, p. 306)

FUENMAYOR also criticizes the "radical enlightenment" concept (whose aim was to escape the very strong rigidity of the traditional **values systems**). The Enlightenment, through MONTESQUIEU and ROUSSEAU, for example, pretended during the 18th C. to invent a constructed social way of being. However it is historically obvious that it is very difficult to fully disengage oneself, even from such a constructed cultural setting -obviously always based on an **ideology**. FUENMAYOR clearly believes that we should escape from even this form of subservience and become actors- or at least witnesses- in our own right. It seems to be quite a tall order. While absolute **objectivity** is a mirage, uncritical cultural relativism is a swamp because it is so difficult to take distance, from the deeply hidden prejudices one inherits from his/her own culture

In a critical comment of the Merida School work, J.C. MINGERS summarizes the proposed **methodology** as follows: " Briefly, this consist of:

- 1) developing a number of interpretations...of what the **phenomena** might be
- 2) comparing the phenomena with these different interpretations
- 3) conducting a debate between the various interpretations, given the results of the comparison

" This all leads, not to some particular result or agreement, but to a richer **understanding** and the possibility of further and deeper interpretations" (1992, p. 338)

M. JACKSON states, as a final **evaluation**: " Interpretive systemology is emancipatory... It demonstrate the oppressive role that **organizations** play in the power **structure** of the society" (2000, p. 299) As such, it is obviously a very useful tool. However "...using marxist ex-

planations allow the interpretive systemologists to assert their emancipatory credentials, but only at the expense of the **phenomenology** they claim to embrace" (Ibid)

Such a conceptual merry-go-round of **frames of references!**...And glints of GÖDEL's unavoidable **incompleteness** and the resulting **ontological skepticism**.

→ **Clanthink; Conversation; Design inquiry; Distinction; Frankfurt School; Metasystem transition theory; Observer; Weltanschauung**

1767

INTERRELATIONS ¹⁾

"The totality of **constraints** holding between the possible combinations of the **states** of two or more systems" (M. TODA & E.H. SHUFORD, 1965, p.26).

This subtle definition is also satisfactory if applied to **subsystems** within a system. In fact, what the authors thus define is the concept of "relation".

In some sense, it must be admitted that "inter-relations" is kind of a pleonasm, but it seems quite a useful one!

1768

INTERSUBJECTIVITY ^{1) - 4)}

The result of the **process** of mental and psychological **interaction** among individuals.

As **observers** gain **knowledge** of their **environment** only within the **limits** of their own internal perceptive and conceptual capacity (as a result of **organizational closure**), intersubjectivity, hopefully leading to **consensus**, becomes the unavoidable substitute for **objectivity**, which is merely an abstract and idealized **concept**. In K. KRIPPENDORFF's words: "Intersubjective verifiability is a weaker but more easily achievable form of **objectivity**" (1986, p.41). We would say, in this case, that the very **meaning** of "**objectivity**" must be deliberately adapted.

1769

INTRANSITIVITY ^{1) - 3)}

T.R. BURNS and L.D. MEEKER draw our attention on a very subtle **invisible** conceptual trap, which is the implicit belief in transitivity which pervades much of our thoughts:

"Intransitivities in Multi-Criteria Evaluation and Decision-Making

"A property of evaluation and **decision** orderings which has been of considerable importance in **decision-making** research and theory is that of **transitivity**: x preferred to y and y preferred to z and (thus) x preferred to z .

"Intransitivities, or **cycles**, e.g. x preferred to y , y preferred to z and z preferred to x , either have been ruled out, certainly in the case of "rational **decision-makers**", or have presented

a serious challenge to the classical **decision** and **games models** with their assumptions of uni-dimensionality (ordinal or cardinal utility scales) and **consistency**" (1976, p.115).

From their theoretical perspective, these authors consider that "... intransitivities are inherent in multi-**criteria** evaluation and **decision-making**. **Fluctuations** in the **criteria** used or in the relative importance of multiple **criteria** with respect to different **sub-sets** of items typically leads to violations of **transitivity**" (Ibid).

1770

INTUITION ³⁾

"A proposal solution to a problem without using a logical **process**" (St. KRIPPNER - pers. comm.).

According to H. POINCARÉ: "It is by logic that we prove, but by intuition that we discover" (1938)

Intuition is generally a "short cut", based on the formerly acquired mental **algorithms** - which may be mere beliefs - and produces a proposal by **analogy** often unconscious. Of course, the **validity** and usefulness of the proposal must be confirmed by making a critical appraisal preferably before and, in the last resort, after any practical experiment.

R. RODRIGUEZ DELGADO wrote: "Abstract intuition has not only perceptive aspects, but is also a qualitative synthesis of conceptual and affective experiences.

Space, time, duration, mobility, immobility, etc...can be experienced from within or can be formulated in definitions. In the first case, they are ineffable intuitions, in the second, communicable **concepts** "...and "Intuitions, as **perceptions**, are absolutely true as individual experiences, and cannot be rationally refuted, but they cannot pretend to be gnoseological **truths** or forms of the external **reality**. Reason can, of course, effect some comprehension of their mechanism and by this means intuition, perception and concept can be integrated, instead of remaining in frequent opposition" (1956)

→ **Autopoiesis; Cybernetics (2nd order); Observer; Ontological skepticism**

1771

INVARIANCE ^{1) - 2)}

A property not affected by some specified **transformation**.

The following classes of invariance can be distinguished:

- Shift invariance, by displacement of the item in conceptual **space**, as for example the group of permutations in arithmetics.
- **Scale** invariance, **similarity** at different **scales**, i.e. **homomorphisms; fractals**

- **Time** invariance, as for example regular **periodicities**.

- **Symmetry** invariance, through the rotation of some perfectly **symmetrical** figure as in geometry.

Conceptual invariance could be added, as for example **isomorphisms**.

B. WALLISER extends the concept to more global qualitative invariance, which maintains the basic characteristics of a system. He gives the genetic **code** in an individual as an example (1977, p.56).

An invariance can be external to the system: something which exists independently of it.

It can conversely exist or be constructed within the system.

This concept, translated into psychology, is a cornerstone of **constructivism**.

E.von GLASERSFELD writes: "A **rule**, no matter what it says or does, posits an actual or projecting regularity in our experience, something that is experienced more than once, something that is repeated and thus in some sense an invariance" (1976, p.115).

J. PIAGET showed how children progressively construct their **perception** of **permanent objects** (1970b) and later on, **permanent** concepts (1970a), i.e. how we acquire invariances, which become the basis of our mental and conceptual **organizational closure**.

In von GLASERSFELD words: "... it is the active **organism** that constructs an invariant item out of two or more experiences by holding on to certain parts of the experience and discarding others" (Ibid).

As explained by S. KATZ, the **constructivist** view is related to the **neural** computer **analogy**: "... (complex) invariances can be established in **neural** computers by means of weighted **summations** of **neural** currents arising from the **activities** of many endings. Hence, the invariances **emerge** as a result of **neural** computation and are not simply identical to, or **transformations** of, **structures** presented ready made to the nervous system. They are, in **Gestalt** terms, "**wholes**" that are more than the sum of their "**parts**", more than the innumerable local **effects** of sensory endings" (1976, p.44).

1772

INVARIANCE PRINCIPLE ³⁾

"We understand **change** only by observing what remains invariant and permanence only by what is transformed" (G. WEINBERG, 1975, p.155).

It is thus possible to perceive an invariant property only through **change** in some other one and reciprocally.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1773

INVARIANCE (Summational)⁵⁾

The preservation of number in a **population**.

According to A.S. IBERALL, who introduces the notion, summational invariance marks a **trend** which can be verified not by dealing with individuals, but through generations.

IBERALL connects this idea with **thermodynamics**, which: "... is restricted to what it can describe in an ongoing **viable system**. It can only deal with **variables** which preserve fundamental properties upon **interaction**: so-called **cyclic variables**, or collisional invariants, or summational invariants" (1973, p.5).

The concept seems related to **critical thresholds** in **composite systems**.

1774

INVARIANCE (Systemic)²⁾

The degree of internal invariance of a system.

In E. LASZLO words: "Cohesiveness and **continuity** within the systems is higher, and rate of **change** lower, than in the **relations between** the systems" (1974, p.33).

Systemic invariance expresses the systems capacity for **self-reproduction**, **self-reference**, **autopoiesis** and **organizational closure**, as well **self-replication** by **hypercycles**. All these complementary properties gives them a considerable (if still limited) **autonomy** in their relations with their **environment**.

In fact, systemic invariance appears through global **transdisciplinary models** whose general characteristics apply to a significant number of systems of quite different kinds.

However, when modeled at a sufficient **level of abstraction**, the distinct models show common structural characteristics and functional **behavior**. As a result, the models are **isomorphic** (not so the systems or entities) and the general invariant properties of the systems become recognizable.

→ **Isomorphisms and Homomorphisms**

1775

INVARIANCE (Time)²⁾

The invariance of the **set** of **states** of a system that do not change in time.

What may change is the presence of the system in one or another **state**. Even so, this is a quite theoretical state of affairs, based mainly on the hypothesis that the different **states** do not influence each other.

According to H. MARGENAU (quoted by A.D. HALL & R.E. FAGEN) the absence of **time** in the equations describing a system is the very essence of **causality** (in its strictly deterministic sense). It is the case for "a system completely specified by n **variables** $x_1, x_2, \dots, x_n$. Then... the **state** of the system is uniquely describable by a **set** of n numbers. To borrow terminology from physics, the **set** of all points in n -dimensions is called **phase space**" (1956, p.25).

This type of **description** becomes thus an **algorithm** with a well characterized **content**, even if it may correspond to a **matrix** of probabilities. (See "**Markovian matrixes**").

However, "When the constants of the **set** become **functions** of **time**, as in progressive **segregation** or systemization, the definition is no longer satisfied" (Ibid).

1776

INVARIANT²⁾

A quantity, **relation**, **process**, **pattern**, **structure**, or generally property unaffected by any **transformation**.

Inasmuch as their basic conditions remain stable, invariants have a high predictive value.

1777

ENVIRONMENT^{1) - 4)}

The internal milieu of a system, separated from the **environment** by the **boundary**, or **interface**.

This is a neologism that this author considers useful and appropriate, because it reflects a well characterized and quite common **situation**.

The environment remains within precise **limits**, with the help of a **set** of coordinated **mechanisms** of **regulation**, which were described in **cybernetic** terms by P. VENDRYES in his noteworthy book "Vie et Probabilité" (1942).

In biology, it corresponds to the French physiologist Cl. BERNARD "milieu intérieur". In BERNARD's words: "In all living beings, the internal medium, which is a product of the **organism**, maintains the needed exchange **relations** with the external medium; but as the **organism** becomes more perfect, the organic medium specifies and isolates itself more and more of the external medium" (1864, reed. 1952).

W. CANNON's **homeostasis** is **dynamic stability** within the environment.

Human systems, such as industrial or business firms, **organizations** of any kind, nations, etc..., possess an environment which appears in the guise of recognized and generally codified values, **norms**, obliged or more or less tolerated of prohibited **behaviors**, **symbolic representations** like **languages**, specific **knowledge**, currencies, emblems etc., and a proper **space** of restricted access to those who are not **part** of the system.

Environment should not however be considered static. W. BUCKLEY observes that the internal **organization** of an **adaptive system** allows it to discern **changes** in its **environment** and discover adequate new **responses** to these. When these **responses** modify the general **behavior** and **processes** in the system, it may be said that its environment has adapted. (1967).

Globally however, the system's environment must remain **autopoietic** and cannot adapt too far away from its basic nature.

1778

INVISIBILITY³⁾

The non **perception** of some **objects**, features or **situations** due to the insufficiencies of our **observational competence**.

The concept, developed by G.de ZEEUW (1992, p.1071-1078), is related to H.von FOERSTER's **cognitive blindspots**: "We do not see what we do not see. **Objectivity** is a **subjects** delusion that observing can be done without him" (Declaration of the American Society for Cybernetics).

According to de ZEEUW the progress toward visibility is a result of the use of more embracing **observational languages**. However, and paradoxically, as observed by Th. SANDOZ: "**Knowledge** and ignorance are directly correlated... (they) grow together and mutually reinforce" (1993, p.1544).

Humanity passed from the magical and mythical **languages** to the rational one, which allowed for the understanding of **phenomena** governed by **linear causality** and **determinism** in its strong (Laplacian) sense.

While obtaining great successes, especially with all kinds of **mechanisms**, the classical logical-rational **paradigm** left misunderstood or downright concealed **nonlinear** relations and is not conducive to a clear **understanding** of complex entities.

According to de ZEEUW: "Nowadays, its (i.e. the classical rational observational **language**) use begins to create excesses itself, however, especially in the case of increasing **competence** for complex **activities** (activities depending on the continued interacting of many actors). It can be argued that the **observational language** limits itself in this way by imposing **models** on the actors in an **interaction**, that is imposes **criteria** for access to **interaction**. Breaking this limit requires new **languages**" (Ibid., p.1077).

A quite closely related concept is "implicitness", which in J. WARFIELD's terms, works "against **referential transparency**". He enumerates the resulting difficulties as follows:

- What constitutes a science is implicit
- Division of many component **concepts** are implicit
- The **Universal Priors** of Science may be treated as implicit, in the presentation of the science.
- **Definition** of concepts by **relationships** may be implicit in the science.
- The underlying basis of arguments in the Theory of **sets** may be implicit
- The underlying basis of arguments in the Theory of **Relations** may be implicit
- The foundations of science are implicit.

- In some instances, especially in newer areas of strategic behavior in response technology, even the theory is implicit" (1988, p.340). In short, we do not know *that* we do not know (and *what* we do not know).

The quick expansion of many conceptual tools addressed to **complexity** seems however to announce the **emergence** of a new and wider **language**, including for example Prigoginian **thermodynamics**, **fuzzy sets**, **catastrophes**, **fractals**, **connectionism**, **percolation** in **composite systems** and **chaos models**.

Such an expanded **language** could reduce invisibility.

In any case, in D. MEADOWS et al. words: "One can never be fully aware of all one's biases. But one can be aware that one is unaware and deliberately expose oneself to **situations** in which biases can be discovered (the best way is to 'hang out' with whomever one regards as the enemy)" (1982, p.278).

1779

INVISIBLE HAND: a systemic reappraisal ³⁾ - 5)

Adam SMITH's invisible hand was a dubious - if not gross - presystemic simplification.

In words of P.M. ALLEN: "Because of the fallacious **analogy** with the approach to **equilibrium** of an **isolated physical system**, in some way, there was an "invisible hand" guiding the **evolution** towards *the equilibrium state*, and hence in some sense that "governments" or "planners" had only to alleviate marginal areas of socially unacceptable inequality or hardship while **events** moved inevitably towards the *best solution*... Our new (i.e. **irreversible thermodynamics**) perspective tells us that this is not the case, that a **choice** of futures may indeed exist, and that these possible futures are of different "**optimalities**", some being more "efficient" for certain points of view than others" (1980, p.279).

This, of course, complicates enormously the **governance** of economic, social and political systems, as it introduces subjective - that is controllable and frequently contradictory - **evaluations** (which of course, were always present, if not acknowledged).

The "invisible hand" in fact, proposed a **homeostatic model** of economy and society, ignoring **instabilities**, **threshold crossings**, **emergence** and **chaos**. Such a concept is still implicit even in Keynesian economics and, of course in many technical tools used by economists.

1780

INVOLUTION ¹⁾ - 5)

"Natural shrinkage or decline of an **organ**" (H. SELYE, 1975, p.468)

A near synonym for "atrophy".

It seems that this **phenomenon** is proper to *any ageing system or subsystem* which is not anymore able to obtain the sufficient **inputs** of **resources** needed for its proper **maintenance**.

1781

IRREDUCIBILITY ¹⁾ - 3)

The impossibility to understand the global character of a system by merely studying its **parts**.

This is E. LASZLO's formulation of the non-**reductionist** stand of systemics (1974, p.212).

Systems are not merely **summative**, they are **integrative**, implying thus the existence of **communication networks**, **interactions** through many different **feedbacks**, selective **constraints**, and the consequent impossibility to understand fully the **parts** as working **elements** in the system, when their reciprocal horizontal and vertical **links** are severed, or simply not taken in account.

1782

IRREVERSIBILITY ¹⁾ - 3)

The **transition** by which **time symmetry** is broken.

The basic idea of irreversibility was developed in a rational way by the French philosopher E. QUINET (1870) and stated precisely by DOLLO (1893).

In 1924, A. LOTKA observed that absolute **reversibility** should be possible only if frictional resistances were totally absent, a completely illusory assumption in "real **processes**" which "are always irreversible" (1956, p.25-26).

A satisfactory theoretical basement for the concept of irreversibility has been finally established by I. PRIGOGINE and his Brussels school.

PRIGOGINE writes: "Rational mechanics knows only reversible **time**, whereas the direction of **time** plays a fundamental role in the biological and human sciences. It is true that in the Nineteenth Century the problem of the direction of **time** was incorporated in physics through the **second law of thermodynamics**. Still the contrast between the idea of **evolution** in physics and that in biology or sociology is striking. In physics, the increase of **entropy** expressed by the **second law of thermodynamics** shows a tendency toward a progressive "disorganization" of the system. On the other hand, biological or social **evolution** is accompanied by progressive **structuration**..." (1976, p.94). And: "Life corresponds... to an inscription of irreversibility into **matter**" (1985, p.9).

To explain irreversibility PRIGOGINE and his collaborators created the new **thermodynamics of systems far away from equilibrium**, which does not contradicts classical **thermodynamics** (quite the contrary), but generalizes it through new concepts related to **complexity**, such as **giant fluctuations**, **stability thresholds** and **dissipative structures**.

As a consequence of this work, the subjectivist interpretation of irreversibility (in physics and mechanics) as attributed to the **observer** incapacity to perceive the conditions of **reversibility** and to produce it, as could be done by **MAXWELL's demon**, is now abandoned, as well as CHANDRASEKHAR's argument, quoted by PRIGOGINE, that "a **process** appears irreversible (or reversible) according as whether the initial **state** is characterized by a long (short) average **time** of **recurrence** compared to the **time** during which the system is under **observation**". PRIGOGINE writes: "According to this point of view, irreversibility would appear as an artefact due to the **time scale** of **observation**!" (1989, p.77).

Sensibility to initial conditions, as a basic characteristic of **deterministic chaos**, results in a new understanding of the meaning of **irreversibility**.

1783

IRRITABILITY ¹⁾

Reaction of a system to reversible **disturbances**" (L.von BERTALANFFY, 1969, p.80).

According to BERTALANFFY, such **disturbances** are "smaller **waves** of **processes** surimposed on the continuous **flux** of the system... after which the system comes back to its **steady state**, and **autonomous** activities in **periodic fluctuations**" (ibid).

V. TURCHIN sees irritability as conducive to a **constraint** (F. HEYLIGHEN, pers.com.).

→ "**Resilience**"

1784

"IS" and "OUGHT" MODES in SYSTEMS HEURISTICS ³⁾

W. ULRICH, as quoted by R.L. FLOOD and M.C. JACKSON, proposed a "Critical Systems **Heuristics**", based on two types of questions.

The first type, the "What is" or "Who is" type of questions, aims at discovering the factual aspects of the considered **situation**. Examples are:

- Who is actually the **decision** taker?
- What is the actual **purpose** of the systems **design**?

The second type of questions is designed to explore unclear aspects of the considered **issue**, as for example:

- Who ought to be the client (beneficiary) of the system to be designed or improved?
- What ought to be the **purpose** of the system?

ULRICH offers in both cases a table of 12 critical questions (FLOOD and JACKSON, 1991, p.206-7).

1785

ISLAND EFFECT ¹⁾²⁾⁴⁾

The appearance and eventual multiplication of original types in secluded **environments**.

Such types can be vegetal or animal species, or specific and original cultural traits in isolated **human groups**.

Isolation favors **differentiation** of any original stock through to "creative" innovation in some specific **niche** in a **biotope**, or more generally, **environment**.

It may also lead to **co-evolution**, when unfettered or suppressed by alien **competition**, for instance by introduced species or characters. End of **isolation** usually leads to the quick alteration or even **destruction** of biological or cultural **diversity**. (Mac Donald may kill regional recipes and the Uros of Lake Titicaca are now adept to Salsa music)

1786

ISLAND SYNDROME ¹⁾²⁾⁴⁾

The diminished resistance to environmental **disturbances** in small systems.

Small systems offer very limited **variety**, because specific traits (genetic, or cultural, for instance) appear in very few individuals, thus becoming easily lost.

This can be observed for example in animal and vegetal **populations** in islands or in natural reserves or parks of reduced extension. A small **population**, with limited genetic **variety**, can easily be wiped out by, for instance, a newly introduced predator or pathogen.

Such an event may well trigger a more extended **instability** in the **ecosystem** and lead to crashes in other species (D. Quammen, 1997).

A similar effect has been observed in small aboriginal populations confronted with invaders. In Southern Argentina and Chile such populations were decimated by infectious diseases against which they had no immunity. Most of them finally became extinct and their cultural traits, as for example **language**, have been totally lost.

Cultural traits may also be lost when small populations accept new **beliefs** and ways of life introduced by colonizers.

1787

ISOCHRONIC (or isochronal, or isochronous) ²⁾

Character of the **propagation** of **effects** of some **event** which progresses permanently at the same velocity in all directions.

This condition is in practice very exceptional.

In fact, the very different **environmental** conditions may easily slow down or accelerate **propagation** in some directions and during some time.

This anisochronic **propagation** produces **time-lags effects** and limits the internal **coherence** of any system, as well as its **synchronization** with environmental conditions.

→ **Networks as imperfectly connected systems; Small world**

1788

ISOCHRONY ¹⁾²⁾

The character of **time**, whose **flow** is regular and uniform.

This definition presents some difficulties. In the first place, the **perception** of the flow of time is subjective. Moreover, if meted through its **effects** in biology, or mechanics, or whatever, different **rythms**, and **periodicities** appear, which can be compared only by clock-works, in itself a human construction (A. MIS-SENARD, 1940)

P.R. MASANI writes that time is "isotropic" - which means in his words that "the past-future distinction is objective" (1998, p. 71). Truly, "**isotropy**" is a property of **space** whose extension to time is debatable.

However iso- or anisotropic effects in the **propagation** of some **events** (for example a new technique) can be meted in terms of time.

1789

ISOLATE ¹⁾⁴⁾

A group of **elements** sharing some peculiar characteristics and, or **relationships** within some secluded **environment**.

This general **model** applies to some archaic human **populations** (for ex. some former Amerindian groups) or animal or vegetal relics.

Isolates are always in a dangerous position, being very vulnerable to any environmental **change**, as for ex. the introduction of some new species.

There are also cultural isolates, i.e. very small collectivities that maintain the last vestiges of a **culture**, or **religion** (for ex. the Parsis in India), or a **language** (for ex. the Guanches in the Canaries Islands before their overwhelming by Spanish colonists).

In most cases, the members of the isolate are well adapted to their existing surroundings, but at the price of losing their **adaptability**. This generally leads them to their doom.

1790

ISOLATION ^{1) - 3)}

A hypothetical **situation** of an entity, or system completely devoid of any **interrelation** with an **environment**.

This a pure **abstraction**, related to the theoretical **thermodynamical model** of the "**isolated**" system submitted to absolute entropical **decay**.

In practical **situations**, isolation should always be qualified, as relative, partial and/or selective in **space** and **time**.

1791

ISOLATION and REPRODUCIBILITY ¹⁾

According to N. PEGUIRON: "The isolation (of **processes** in order to study them) is used to show the specificity of the **effects** resulting from a **cause**: it is thus the basic instrument for seeking reproducibility. This act, when performed, implies the supposition that the essence of the **phenomenon** which is studied is retained; it thus restricts the field of investigation to the **isolated systems**: the properties of a (**connected**) system, basically resulting of its **interactions** with its **environment** totally escape from it" (1989, p.10).

Accordingly, the well known "...et ceteris **paribus**" principle, generally *implicit*, is usable only in order to obtain **abstractions** that can be applied to monocausal and repetitive **situations**.

PEGUIRON adds: "But there is something worse: If pushed to its extreme limit, the isolation **process** is an **abstraction** which is not only completely impossible to perform practically, but, should it be, would not let anyone to account for the **phenomena**, as we observe them" (Ibid).

It must be however recognized that, without the isolation (and basically **reductionist**) **method**, it would not have been possible to start the upbuilding of modern science and, 350 years later, finally tackle **complexity**.

1792

ISOLATION (Functional) ²⁾

"Separation of an entity from its **environment** by virtue of its relatively more rapid intrinsic **reaction rates**" (T.F.H ALLEN & T.B. STARR, 1982, p.268).

ALLEN and STARR state: "Entities may be functionally isolated while being spatially interdigitated with that which comprises their **environment**" (Ibid.).

This seems to correspond to St. KAUFFMAN's **frozen cores**.

1793

ISOLATION MECHANISM ¹⁾

The division of a **population** in two or more separate **populations** by severance of their **communication links**.

This concept applies to "**populations**" in a very generalized sense. It can be observed in animal and vegetal species (see J.T. BONNER, 1988, p.236), but also, for example in linguistics, where the phonemes and words, being carried by numerous individuals, are assimilable to **populations**.

It generally results in a progressive **drift** and growing differences between the **groups** that have been cut off from each other. This **mechanism** is specially effective when the condi-

tions in the respective **environments** become sufficiently differentiated to **filter** in different ways the **random** individual mutations or variations that occur.

1794

ISOMORPHISM ¹⁾ - 2) - 3)

"A **mapping** which not only involves a one-one correspondence of **elements**, but which also preserves operational characteristics" (1968, p.108).

As St. BEER explains, this means that the results of an **operation** on **elements** of one **set** correspond to the results of the analogue **operation** on their homologues in the other **set**. Thus, there are also relational isomorphisms, which are much more interesting than structural ones.

While an isomorphism may be considered as the perfect **analogy**, no **model** is ever totally isomorphic to the modelled **object** or system. The really significant use of isomorphism is to allow for the creation of *classes of models* characterized by the same properties. This enables us, up to a point, to compare **structures** or **functions** of different **concrete systems** and operate meaningful generalizations. This in turn permits us a certain degree of **algorithmization** of the **knowledge** of numerous complex **entities** or **situations**, which may be more or less similar. (thus leading to **algorithmic compressibility**).

L. TRONCALE uses the term "isomorphies" apparently as a synonym of "isomorphisms" and defines it as follows: "A formula, **pattern**, **structure**, **process** or **interaction** demonstrated to be precisely the same, but in general terms, across many disciplines, and many **scales of magnitude** of real systems despite the obvious difference of the **parts** of the diverse systems" (1985, p.47).

He comments: "Isomorphies are completely **context-independent** and **content-rich** (have **meaning** in themselves and alone). They are manifest only in **context**, and observable only by comparison of many **contexts**".

He goes still farther, adopting a quasi-platonic stand: "The existence of the same **interaction** across many separate **levels** implies that the isomorphy is actually as fundamental and real, perhaps more fundamental and real than the **parts** at different **scales of magnitude** that exhibit the **relationship**. In this formulation the abstract isomorphy-across-systems and the physical manifestations-of-systems are equally "real" (Ibid).

In a quite different perspective, and according to J.van GIGCH the search for isomorphisms could be computerized through some adequate software, as for instance APPLE's HYPERTEXT and HYPERCARD. (1988, p.269). Quoting J. SCULLEY, he writes: "... the computer will con-

fer the (power and) perspective to compare and contrast (read: 'find isomorphisms') and so free ourselves from the limits imposed by specialization" (Ibid.).

1795

ISOMORPHISMS and HOMOMORPHISMS ¹⁾ - 2) - 3)

Isomorphisms should be carefully distinguished from homomorphisms.

According to R. VALLÉE, the **pluridisciplinary**, (or better, **transdisciplinary**) character of **systems theory** "... is a result of one of its fundamental **goals**, i.e. to show, in the best case, structural isomorphisms between systems pertaining to different disciplines (or between **representations** of these systems). Such isomorphisms, which most generally, if not always, are merely homomorphisms, were already heralded by **cybernetics**, as in the title of WIE-NER's work...

"This search for isomorphisms, or more modestly, homomorphisms, leads to the concept of **model**, which allows for the **representation** of a **category** of systems. The ideal of an isomorphic **representation** is however misleading. As KORZYBSKI reminded us, "the **map** is not the territory" (1990, p.56).

St. BEER enounces a similar opinion: "Having refined the conceptual **models**, the contents of mind, ... the scientist produces two deeper-level homomorphic **models** - and these may well be isomorphic with each other" (1968, p.113).

1796

ISOPLETH ²⁾⁵⁾

A line of equal value in a graphical **representation** (M. CHISHOLM, 1975, p.62).

Isopleth can be used for example to represent contour lines, rainfall, temperatures, atmospheric pressures, etc. It allows for a meaningful **connection** among many scattered **observations** through the grouping of numerous statistical ones. Two successive isopleths define an area wherein approximatively similar conditions do exist.

Their use is by no means limited to geography or meteorology.

→ **Choropleth**

1797

ISOPRAXIC BEHAVIOR ²⁾⁴⁾

A behavior "in which two or more members of a **group** communicate by doing the same thing". (P.D. Mac LEAN, 1978, as quoted by R. Numella Caine and M. CAINE, 1994, p.61).

A good example is wearing a badge of some **organization**.

"The constitutional part of us that reinforces **routine** has a powerful means of making it known when there has been a break in **rou-**

tine... In like vein, anything that reinforces **rou-tines** may have a reassuring, calming effect" (P. D. Mac Lean, Ibid)

Such behavior reinforces in a ritualistic way the **coherence** of the **organization**. It seems to be a more elaborate human form of some animal reciprocal signaling in **herds**, fish **shoals**, bird flights, etc...

1798

ISOTROPY ²⁾

The character of a **space** or **environment** presenting the same properties in all its extension.

Isotropy is quite an abstract concept, of mathematical origin. It is however useful to help the **understanding** of any **concrete environment**, which is merely *more or less* isotropic, respective to some property.

→ "**Anisotropy**".

1799

ISSUE ¹⁾

A **situation** generating a wide public concern.

This term is used by J. WARFIELD in his methodology of **Generic design** and "Interactive Management". See "**Management (Interactive)**".

1800

ITALIAN ASSOCIATION FOR RESEARCH ON SYSTEMS ¹⁾

The "Associazione Italiana per la Ricerca sui Sistemi" has been founded in Milano and Brescia by G. MINATI and a group of Italian systemists. It is sustained by the "Fundazione Barberini e Centoni per la Correlazione".

It organizes tutorials and international meetings.

A Computerized Enquiry System, or Semantic Information Retriever has been created by MINATI, who also published an "Introduzione alla Sistemica" (1996).

The Association is specially interested in didactics and education and closely collaborates with the OPPI, "Organizzazione per la Preparazione Professionale degli Insegnanti" (Milano) which has adopted systemic **methods**.

1801

ITERATION ¹⁾ - 2)

The **cyclic** repetition of some **process** or **routine**.

Iteration is much used in computation, to approach some desired result by progressive **convergence**.

Iteration is also the base for **recursivity** in **autopoietic** and **hypercyclic processes**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

On the other hand, J. BRIGGS and F.D. PEAT state that, in **chaotic processes**: "It is the iterating nature of the **nonlinear** equations (that represent the interconnected nature of **dynamical systems**) which makes impossible the improvement of **predictions**" (1989, p.69).

J

1802

JAMMING TRANSITION²⁾

The blockage of a **flow** through overstuffing of flowing **elements** in a **channel**.

M. BUCHANAN gives the following example: "Put just a few beans or grains of coffee through a chute and they will flow quite easily. Try to send too many through at once and the chute jams as the grains get **frozen** in place" (2000, p.31). Jamming transitions are quite a common **phenomenon**. It can be observed for ex. in traffic jams, or in stampedes at too narrow outlets in a theater or a stadium.

→ **Density (Critical)**

1803

JOINED

→ **System (Richly or poorly joined)**

1804

JUNCTION

→ **Adding junction**

1805

JUST NOTICEABLE DIFFERENCE¹⁾

The least quantitative **stimulus** that can be perceived by an **observer** or experimenter.

This is a very important notion for **systemics** and **cybernetics**, because, under the **threshold of perception**, we fall into the realm of **invisibility** and we may well incur into "ignorance of our own ignorance". As a consequence, we may fall prey to unsuitable **modeling**.

W. Mc CULLOCH writes that JND "... has been found in the middle range of **perception** to be roughly proportional to the size of the **stimulus**" (1974, p.6).

However, the JND **threshold** becomes lower for a trained **observer** of some specific kind of **phenomena**: Mc CULLOCH gives the example of the **Golden Proportion**, much more easily perceived by architects, sculptors and painters.

K

1806

K - STRATEGY^{1) - 2)}

A system's strategy that aims at having fewer, larger and higher **energy-using elements** whose **life spans** are long and rate of replacement low (adapted from R.N. ADAMS, 1988, p.134).

ADAMS explains as follows this **concept**, borrowed from **ecology**: "**Hierarchical structures** behave (according to) K-strategy: they are large but consume more **energy**" and "They take a longer **time** to come into being" (p.134).

K-strategy is better adapted in conditions of general **environmental stability**, where **elements** or **parts** are in less danger of individual destruction.

However, when systems constructed according to a K-strategy dissolve in **parts** due to some considerable environmental **disturbance** these **parts** "...often cannot sustain themselves and thus need to reorganize along different lines in order to survive" (Ibid).

In many cases, they are not able to do this: scattered **populations** close to extinction, imperial **structures** losing **control**, disorganized conglomerates are examples.

1807

KAM THEOREMS^{2) - 5)}

"KAM" is for the Russian mathematicians and physicists A.N. KOLMOGOROV, V.I. ARNOLD and J. MOSER. The theorems are about the **dynamics** near a **periodic** orbit. They show that for some **Hamiltonian systems** (i. e., practically **homeostatic**) affected by slight **perturbations**, there may exist numerous different **initial conditions** that may produce **quasi-periodic** movements, describable by convergent series, and corresponding to **toroidal attractors**: The **threshold of chaos** can be, or not, crossed.

ARNOLD showed that this applies, at least in some cases when **perturbations** are quite small, to POINCARÉ's **n-bodies problem**.

For **non-Hamiltonian systems**, in I. PRIGOGINE's words: "KOLMOGOROV" (K-) systems exhibit a complex **behavior** of individual **trajectories**, like exponential **divergence**, to the effect that no finite **algorithm** can reliably compute the motion of **phase points** sensibly faster than the **dynamics** itself. Systems of this kind include geodesic **flow** on surfaces with negative curvature..." (1986, p.5).

K-FLOWS

(Also named after KOLMOGOROV)

K-flows are characteristic of near-**chaotic systems**. J. CASTI writes: "Their **behavior** is at the limit of **unpredictability**, in that having even an infinite number of **measurements** of

where the system was in the past is of no help in predicting where it will be found next. K-flows are widespread among systems in which collisions between particles dominate the **dynamics**" (1990, p.288).

In synthesis, the borders between **ergodic systems**, **thermodynamically unstable** ones and **chaotic** ones are **fuzzy**.

→ **Baker transformation and LIAPOUNOV exponent**

1808

KHEPERA ROBOT

→ **Robot (Khepera)**

1809

KIN SELECTION⁴⁾

A **mechanism** leading to the constitution of social **groups** based on genetic **relationships**

This **process** is observed mainly, but not exclusively in insect societies.

W.D. HAMILTON showed that "... the total **fitness** of individuals was actually the sum of two different sources: a direct **component** stemming from an individual's reproductive effort and an indirect component stemming from the reproductive effort of relatives. The magnitude of the indirect component depends on the degree of genetic **relationship** to those relatives, and there are thus conditions under which it may pay to forgo reproducing yourself and instead assist in the rearing and defense of relatives". (J.T. COSTA, 1997, p.151)

COSTA observes: "...social **behavior** may have evolved independently several times, with varying **patterns** of gain and loss of particular social characteristics" (Ibid).

Socialization through kin selection implies other significant aspects as: **recruitment communication** (in insect societies, mainly through **pheromones**), **aggregation**, **patch** restriction and **boundaries** marking.

Similar **processes** are very probably at work in human societies. Archaic ones were generally based on specific forms of kinship. In modern ones one may wonder if **ideologies** or common interest do not substitute kin **selection** and be a new type of **aggregation** factor.

The importance of kin selection and the way it leads to wider and more complex social **behavior** have been explored by D.C. QUELLER (1985, p. 366-67)

→ **Meme; Memetics**

1810

KNOWLEDGE³⁾

"The result of **learning** and **cognition**, tested in practice (ideas, conceptions)" (UNESCO - UNEP Glossary, 1983, p.17).

Of course, many other definitions have been proposed. The UNESCO Glossary however adds significant comments: "Includes the **cognition** of real **objects** and **phenomena**, laws of nature

and society, **environmental** problems and the correct reflection of all this cognized **information** in the **process** of thinking" (ibid). Taking in account the following reflexions, bearing on the general conditions of knowledge, this is as good a general definition as any other.

H.von FOERSTER observes that there is "... an almost universal confusion in which "knowledge" is seen as a commodity, i.e. is identified with substance rather than with **process**... An educational system that confuses **learning** with the dispensing of goods called "knowledge" may cause some disappointment in the hypothetical receivers, for the goods are just not coming: there are no goods" (1974, p.21).

This view about knowledge thus enounced is notwithstanding generally unheeded by A.I. specialists who, in D. GREGORY's words, believe that:

"Knowledge is a commodity. We can trade it, teach it, learn it, remember it, represent it, discover it...

"Knowledge is distinct from its knower – just like **data** are distinct from computer disks;

"Knowledge is **sets** of true **facts** together with the **rules** for combining them;

"Knowledge can be reduced to **sets** of primitives – just like **matter** is ultimately reducible to fundamental particles" (1993, p.67).

For the practical application of these disputable views, which seem to confuse knowledge with simple **information**, or even mere unstructured collections of **data**, see hereafter T. ÖREN's **Knowledge's General Taxonomy**.

As an antithesis, D. GREGORY states "PASK's idealist axioms":

"Knowledge is a **process**, not a **state**. It is not "that which is known", but the **process** of knowing (alias observing, alias distinguishing).

"Knowledge consists in coherent systems of **relationships** that connect knowers with their world, not **facts** with each other, independent of their knowers... (note that the sky is not blue to insect eyes – But then who is to say that any concept of "sky" exists for an insect, to begin with).

"Primitivity is with respect to the knower, not the world: knowing that food satiates hunger is elementary knowledge for a small child. but very elaborate for a biologist" (1993, p.68).

In the same vein as von FOERSTER, D. BOHM and F.D. PEAT write: "Knowledge of reality does not therefore lie in the **subject**, nor in the **object**, but in the dynamic **flow** between them" (1987, p.67). In J.L. VULLIERME words: "The object of knowledge is the knowledge of the **object** by a local, and localized **observer**" (1990, p.151).

Knowledge is thus the result of a **recursive** transaction between an **observer**, already endowed with a basic cerebral **organization**, and reality and, consequently, supposes a perpetual readjustment of the internal **state** of the **sub-**

ject. This internal readjustment tends however to become more and more stabilized through **time**, due to the formation of **learning algorithms** (individually and socially conditioned).

Finally, in W. REEVES words, knowledge is: "...neurally incorporated and organized **information** (which) supplies us with a usable and lasting sense of the world" (of course, in our own terms) (1992, p.1102).

It is noteworthy to emphasize this opinion, based on the neurology of **communication**, in relation to some of the following entries which precisely accept in an implicit way the quite different notion of knowledge as something tangible that can be stored, located, transformed, etc... (This viewpoint proper to computer scientists should not be uncritically accepted outside of computer science).

As a collective cultural endeavor, I. PRIGOGINE observes that: "... the ideal of complete knowledge, which has haunted Western science for three centuries... is only meaningful for the limiting case of **stable dynamic systems**. The message of the **2nd law** is precisely that we are living in a world of highly unstable motions, to which the classical ideal does not apply" (1986, p.2).

In this sense, the complete and absolute knowledge ideal should be replaced by non-contradictory **coherence** in knowledge, submitted to constant **validation** through a **falseability process** "à la POPPER".

1811

KNOWLEDGE: a pragmatic and operative view^{1) - 5)}

It would be quite irresponsible to broach such a philosophical problem as knowledge in a short and superficial way, while it occupies the best minds since 25 centuries.

For our purpose, "knowledge" is that which allows complex systems to sustain themselves and to act.

From this pragmatic viewpoint, B. ZEIGLER states:

"A system "knows about "a **class** of **objects**, or **relations**, if it has an *internal representation* for the **class** which enables it to operate on **objects** in this **class** and to communicate with others about such **operations**.

"Thus, if a system knows about **x**, a **class** of **objects** or of **relations** on **objects**, it is able to use an internal **representation** of the **class** in at least the following ways: receive **information** about the **class**, generate **elements** in the **class**, recognize members of the **class** and discriminate them from other **class** members, answer questions about the **class**, and take in-

to account **information** about **changes** in the **class** members" (1986, p.15).

Such an internal **representation** is a **set** of more or less elaborated **models**, acquired through a **process** of **learning**. As shown by numerous experiments, somewhat similar **models** seem to be already present under rudimentary forms even in inferior animals.

This leaves open questions about the degree of **consciousness** that must necessarily go paired with knowledge.

1812

KNOWLEDGE ACQUISITION (Taxonomy of)⁵⁾

T.ÖREN propose the following – and quite general – taxonomy (1990, p.22):

see table below

All this seem quite similar for natural intelligent systems. "Changing **representation**" can be a tricky business, from the viewpoint of **simulation of concrete systems**.

Table: see entry **KNOWLEDGE ACQUISITION (Taxonomy of)**

Criteria for discrimination	Types of knowledge acquisition
Sources of input knowledge	
Exogenous	
Acceptance	Input Sensation
Detection	Knowledge detection Perception Recognition
Endogenous	
Generation of implicit input	Generation of Questions Hypotheses Alternatives Recognition of unstated, implicit or commonsense know- ledge
Anticipation of the future	Generation of anticipatory knowledge Anticipation of future values of inputs , parameters , structures
Processing of input knowledge	
Changing representation	Decoding
Filtering	Knowledge discrimination Selection Pattern recognition Regulation
Assimilation	Knowledge assimilation
Future knowledge processing	Building a passive knowl- edge base
ability of the system is not affected by acquired knowledge	
is affected by acquired knowledge	Machine learning

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

1813

KNOWLEDGE ANALYSIS (Taxonomy of)⁵⁾

T.ÖREN makes the following **distinction** in his knowledge analysis, from the viewpoint of **machine** intelligence (1990, p.27).

see table middle column

The whole concept of knowledge *analysis* should be carefully considered, and very specially the idea of knowledge *decomposition*, which could easily throw the baby of interconnected **meanings** with the bath water of digital computerization.

1814

KNOWLEDGE (Analytic and Systemic)^{1) - 3)}

M. LIU synthesizes in the following tables the differences between both types of knowledge. (1989)

see tables below

1815

KNOWLEDGE as a control on behavior¹⁾

According to F. HEYLIGHEN, "Knowledge can be defined as the ability to choose adequate actions from the **repertoire**, where *adequate* means: securing the **survival** of the system within its **environment**. Knowledge *selects ac-*

Table: see entry **KNOWLEDGE ANALYSIS (Taxonomy of)**

Criteria for discrimination	Types of knowledge analysis
Finding composition (and/or) decomposition	Knowledge decomposition
Detection of elements	Lexical analysis Syntactical analysis Semantic analysis
Detection of meaning	
Characterization to enhance:	Knowledge characterization (pragmatic analysis)
Comprehensibility	Knowledge comprehensibility
Documentation	Annotation On-line Off-line Documentation On-line Off-line
Investigation Usability	Knowledge ventilation Knowledge usability
Referability	Knowledge base management
Modifiability	Knowledge modifiability

tions from the **variety** of potential **actions**, in the same way that natural **selection** selects by destroying inadequately behaving systems. The difference is that knowledge does not destroy

actual systems, it only eliminates *potentialities*. Knowledge can thus be defined as a substitute or *vicarious selector*, which internally represents – and thus allows the anticipation of – the selective **action** of the **environment** (see CAMPBELL, 1974)" (pers. com.).

Knowledge is, of course, subjective (i.e. proper to an **observer**) and thus merely **plausible**, which means that its adequateness cannot be totally guaranteed.

HEYLIGHEN makes another important point: "What distinguish knowledge from **control** in the more traditional sense, is that cognitive **control** does not depend on a specific, **fixed goal** that the system is supposed to achieve. The only, very broadly defined **goal** is **survival** of the **identity**..." (Ibid).

In other words, knowledge is a tool for **organizational closure**.

And: "Moreover, cognitive **control** is supposed to cope with a complex **environment**, and will in that way have to represent as much as possible features of that **environment** that are relevant to **survival**" (Ibid).

Here again, the practical results depend on the quality of the "maps" (KORZYBSKI) or the **models** (ASHBY).

Table: see entry **KNOWLEDGE (Analytic and Systemic)**

1. Levels and Nature of Knowledge

Level	Analytical Approach	Global Approach
1. Construction of the object of study	Determination of its permanent properties Data, Informations	Delimit the system under study. Define convenient research tools
2. Description of relations and, or transforms between objects	Universal and permanent laws	Definition of the observables. Elaboration of a specific language if necessary. Use of conceptual tools
3. Methodology . Enounce means obtain valid knowledge	Normative methods applicable to all situations Selection of alternative methods in accordance with objectives	Research and action specific to the situation under study. Heuristics
4. Reflexion about the foundations of knowledge	Adoption of a unique logic. Formalization of a normative epistemology	Reflexion on logics. Research and explication of paradigms underlying the knowledge mode being used.
5. Critical epistemology		Epistemologic debate. Creation of new paradigms .

2. Orientation of the two **modes** of knowledge

Deterministic analytic approach	Global approach
Obtaining the general and permanent properties of classes of objects	To know the general and the specific of complex systems or situations
Be able to predict with the maximum certainty the evolution of their transformations .	Locate evolutions in history Predict conditionally
To control the evolution of the objects and to produce artefacts .	Defining heuristics to understand and also act in singular and unique situations . Taking in account indeterminacy . Steer open processes . Enhance autonomy . Develop learning processes

1816

KNOWLEDGE BASED SYSTEMS: An evaluation^{3) - 5)}

Peter J. DENNING writes:

"Knowledge based systems (KBSs) are founded on the assumption that an expert works from a complete theory of the **domain**. Once a theory is articulated as a **set** of **rules** and stored in a database, the superior power of the computer can draw inferences much faster than the expert..."

What is thus not accomplished "...cannot be blamed on a lack of computer power, **memory**, research effort or cooperation of experts. An explanation gaining credence is that experts themselves do not work from complete theories, and much of their expertise cannot be articulate in **language**" (1991, p.495).

It remains quite doubtful if any complete theory can be obtained of any specific **domain**. This limits somewhat the KBS modeling **reliability**, because computer treatment needs an **algorithm**, which does not incorporate new "hunches" or renewed **intuition**. However KBSs can be progressively perfected.

In any case: "Education that equates expertise with models can inhibit the development of good judgement" (Ibid.).

1817

KNOWLEDGE (Construction of)³⁾

The construction of knowledge is basically the acquisition of perceptive and conceptual **invariances**, "...with which to explore, order, and predict experience" (E von GLASERSFELD, 1976, p.116).

According to von GLASERSFELD: "If we accept the notion that rational knowledge involves the generation and use of **invariances** and **rules**, we cannot help asking how these **invariances** are generated and what they concern" (p.119). This is the "prime mover" concept of **constructivism**.

The subject was also broached early by J. PIAGET, who wrote in his "Epistémologie génétique": "Knowledge should not be conceived as pre-determined, neither within the internal **structures** of the **subject**, as they result from an effective and continuous **construction**, nor in the pre-existent characters of the **object**, since they become known only through the necessary mediation of these **structures**" (1970, p.5).

He also stated: "Cognitive **processes** appear then simultaneously as a result of the organic **self-regulation** of which they reflect the basic **mechanisms**, and as the most differentiated organs of that **regulation** within the **interactions** with the **environment**" (1967, as quoted by I. PRIGOGINE, 1973 b).

It is somewhat difficult to harmonize these views with the **autopoietic** view of the **observer** endowed with perceptual and conceptual **organizational closure**. This compiler believes that the physiological and nervous **capacity** to construct knowledge is innate, i.e. organizationally closed, but that it gives the **subject** the potential for **learning** and, through **learning**, create a perceptual and conceptual **structure** that ends up more and more **autopoietic**. Such a view is consistent with the **progressive stabilization** – and eventual **sclerosis** – of personality and worldview.

From a practical viewpoint M. DODDS and G. JAROS make the following **distinctions**: "**Information** is *descriptive*; it is contained in answers to questions that begin with such words as What, Which, Who, How many, When and Where. Knowledge is *instructive*; it is conveyed by answers to How-to questions. **Understanding** is *explanatory*; it is transmitted by answers to Why questions.... (while) **understanding** presupposes knowledge and **information**... **information** presupposes neither knowledge nor **understanding**" (1994).

This seems quite extreme. Information presupposes at least some **frames of references** if it is to be more than pure **data**.

Table: see entry **KNOWLEDGE DISSEMINATION (A taxonomy of)**

Criteria for discrimination	Types of knowledge dissemination
Based on existence of explanations	
Without explanations	Primary output Access to knowledge bases (data base, model base, rule base, goal base...) Output is generated/transformed by the system Auxiliary output Help facility Guidance Certification
With explanation	Explanation Advice
Based on knowledge channels	
Fixed channels	Coupling Hierarchical Nested Time-varying
Flexible channels	Message passing
Based on number of receiving	
objects/systems	Knowledge transmission
One-to-one	Selective knowledge dissemination
One-to-some	Knowledge broadcasting
One-to-many	Knowledge posting (bulletin board, black-board)
On a common area	Knowledge distribution (journal, lecture notes)
On individual areas	

1818

KNOWLEDGE CONSTRUCTION (Physiology of)^{3) - 5)}

R. FISCHER synthesizes the successive stages of knowledge construction in the **brain** (1992, p.211).

A "primary **repertoire**" is formed "between the 10th to 18th week of gestation... (when) the formation of neurons accelerates, and a fierce competition for neurons to *connect* with other neurons and with sensory cells can be observed. Those who could not link up, die off. These **interconnections** are formed during **development**, prior to experience, and there is evidence for extensive **variance** of **connectivity**, even in genetically identical animals.

"A secondary **repertoire** is in the making during *postnatal experience*: **selection** among diverse preexisting groups of **cells** accomplished by differential modification of synaptic strengths or efficacies *without change in connectivity pattern*. **Responses** of neural **populations** are significantly influenced by similarities between present and past constellations of sensory **signals**. **Perception**, **memory**, **learn-**

ing are consequences of selective **amplification** which leads to increased speed or strength of selected **responses** when similar **patterns** of **stimulation** are repeated"...

"It takes then many years of **environmental** exposure until a third, a more global, **problem solving repertoire** is acquired from the **brain's** self-experience that we have in the mind. This knowing system can generate alternatives that subserve **goal seeking**, alternatives that are selected by the **environment** for **fitness**".

→ **Connectivity**; **HEBB's rule**; **Reinforcement**

1819

KNOWLEDGE DISSEMINATION (A taxonomy of)⁵⁾

The last table in ÖREN's stimulating study of so-called "knowledge" in fact in close relation to artificial **intelligence** in **software** engineering is about **outputs** and **transmission** (1990, p.42).

see table middle column

1820

KNOWLEDGE (Ecology of)³⁾

"The study of **patterns** of **interrelationships** among the various "species" (**subsystems**, **subsubsystems**, etc...) or **fields** and subfields of knowledge" (J.W. CLARK, 1972, p.168).

CLARK, who proposed this conceptual frame, and a corresponding project of "Degree Program in G.S. Studies" emphasizes the necessity to:

"a) preserve the condition of dynamic balance between the "species" and their **environment**;

"b) optimize the overall, symbiotic fruits of **synergistic interactions** among them" (Ibid).

In fact, ecology of knowledge should also introduce other items as, for example, cybernetic and systemic **models** and concepts, as well as some new mathematical tools (**graphs**, **fractals**, **catastrophes**, **chaos**, etc...), all of which permit to interconnect **fields** and subfields in a significant way.

1821

KNOWLEDGE ENGINEERING⁵⁾

"Part of **artificial intelligence** research concerned with the development of **expert systems** as well as with the development of the necessary **methods** and tools" (E. BUCHBERGER, 1987, p.31).

E. BUCHBERGER adds that the role of the knowledge engineer is to build the knowledge base of the **expert system**, starting from the expert's knowledge to create **representations** of the same, compatible and intelligible within the **expert system**, and to introduce in it an in-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Table: see entry **KNOWLEDGE GENERATION (A taxonomy of)**

Criteria for discrimination	Types of knowledge generation
Knowledge generation from real world	Observation Experimentation Instrumentation
Knowledge generation using a model based on: Type of behavior	Simulation Trajectory Structural
Type of change	Continuous Discrete Process interaction Discrete event Activity scanning Discrete arithmetic Finite state machine Quasi continuous Discontinuous Combined Catastrophic
Type of determinism	Deterministic Stochastic
Spatial distribution of models	Spatial
Boundary-valued model	Boundary value Fixed boundary Variable boundary
Network model	Network Bond graph Petri net Queuing network Networkflow
Organization of model	Allopoietic Autopoietic Metamorphic Object oriented Cellular Game of life Self-similar system Fractal
Fixed Variable non-reproducing Self-reproducing	

ference engine, i.e. a device apt to reach conclusions by combining the **elements** of the knowledge base in accordance with definite **rules** (**Inference rules**) (ibid).

1822

KNOWLEDGE EVALUATION (Taxonomy of) ⁵⁾

T.ÖREN establishes that taxonomy as follows (1990, p.31):

see table middle column

This evaluation taxonomy brings about a tool for a very much needed self-criticism of **modellers**.

1823

KNOWLEDGE GENERATION (A taxonomy of) ⁵⁾

T. ÖREN offers the following proposal of taxonomy of knowledge generation by experiential techniques (1990, p.37)

see table left column

Table: see entry **KNOWLEDGE EVOLUTION (Taxonomy of)**

Criteria for discrimination	Types of knowledge evaluation
Intrinsic evaluation of Knowledge	Knowledge reliability Accuracy Completeness Correctness Integrity Consistency of representation Certification of representation
Knowledge base	Knowledge base reliability Completeness Consistency Security
Functioning of a system Knowledge processing action	Diagnosis Correctness of knowledge processing Robustness of knowledge processing
Knowledge processing action of: Self On current action On past action Other system(s) On current action On past action	Introspection Retrospection Monitoring Testing Postmortem analysis
Relative evaluation of knowledge with respect to: Perceived reality	Realism Correctness Validity Verification Qualification
Goal of knowledge processing Range of applicability	Relevance Adequacy
Another knowledge of: Different entity under the same condition Same entity under different condition	Comparison Sensitivity analysis (sensitivity of the entity to the conditions)

It is rather curious that ÖREN did not introduce "chaotic determinism" in his taxonomy.

1824

KNOWLEDGE GENERATION by nonexperimental techniques (A taxonomy of) ⁵⁾

This is ÖREN proposal (1990, p.39):

see table right column

Again, **chaotic determinism** seems to have its place between **determinism** and **randomness**.

These two last tables are very enlightening about the various ways we construct knowledge. Between **induction** and **deduction**, possibly as a form of **induction**, could we not introduce **connection** which seems closely related to **learning** in natural and artificial **intelligence** in systems.

Table: see entry **KNOWLEDGE GENERATION by nonexperimental techniques (A taxonomy of)**

Criteria for discrimination	Types of knowledge generation
Using numerical methods , which can be Deterministic	Computation Optimization Prediction (anticipation)
Stochastic Model is deterministic Model is stochastic	Monte Carlo simulation Statistical inference
Using nonnumerical methods Synthesis	Module interfacing Model coupling Fusion/composition Rule fusion Rule composition Compilation Reasoning Induction Primary induction to formulate: Hypotheses Laws Secondary induction to formulate Theories Deduction Qualitative simulation Approximate (fuzzy) reasoning Guessing Hypothesis formulation Belief formation Certainty factor of belief Belief maintenance
Inferencing	
Speculation	

1825

KNOWLEDGE GENERATIVE (Taxonomy of) ⁵⁾

T.ÖREN proposed what he calls a "paradigm for artificial **intelligence** in **software** engineering" (1990, p.1-55). The eleven following tables reproduced from his paper, also constitute however an interesting challenge in reference to our **understanding** of **brain intelligence**. ÖREN first characterizes the intentions, objects (relations), conditions and ways useful in knowledge generation (p.20).

see table next page left column

It would be interesting to consider this framework from the viewpoints of brain neurology and classical philosophies.

The idea to **reduce** problems should be carefully scrutinized.

1826

KNOWLEDGE (Implicit) ³⁾

The existence of implicit knowledge as a substratum for explicited one has been explored by M. POLANYI (1966).

Table: see entry **KNOWLEDGE GENERATIVE (Taxonomy of)**

Criteria for discrimination	Types of generative knowledge
Intention to generate knowledge	Goal (intention) Subgoal Subgoal (problem reduction)
Objects/relationships used in knowledge generation	Model/design Computational model Optimization model Dynamic model (for simulation) Inference model Rule Decision table Script Frame Slot Semantic net And/Or graph ISA hierarchy Qualitative model Statistical- inference model
Condition to generate knowledge by :	Knowledge generation frame
Experiencial techniques	Experimental frame to generate model behavior observe real-world behavior .
Non-experiencial techniques using Inferencing Optimization Computation	Inference frame Optimization frame Computational frame
Ways to generate knowledge	Schematic knowledge Plan Schedule Agenda Schema Algorithm Procedure Method Heuristic

The establishment of spontaneously organized **connections** among scattered "**bits**" of **information** seems the only way to start to explain how new concepts and theories can appear suddenly in the mind (as testified for example by KEKULE, GAUSS, POINCARÉ, VENDRYES and many others).

The most recent experiments with **neural networks** offer an interesting insight about how this could happen in the **brain** (M. BODEN, 1991, p. 25 – D. GERNERT, 1994, p.128).

A. KOESTLER concept of **bisociation** of **matrices** could be another way to understand how new explicit **knowledge** comes into existence.

Genesis of mental and conceptual **complexity** seems thus to be probably a **phenomenon** of **emergence** through combination. As such, it is very significant for **systemics**.

Table: see entry **KNOWLEDGE IN A COMPUTER (Input and Output of)**

Types of input/output	Additional characteristics	
	Criteria	Characteristics
Numerical	Base Nature Type Precision	Decimal, binary , octal, hexadecimal, etc. Scalar, vector, matrix tensor Integer, real complex Single, double, variable
Textual	Dimension Nature	1-dimensional (string) 2-dimensional (page reader, printer) Natural language processing, text understanding, abstracting, synthesizing
Graphical	Dimension Movement Color	2-dimensional 3-dimensional Still Moving Monochrome Color
Audio	Nature	Sound Speech recognition
Tactile	Nature	Pressure (detect, induce) Vibration (detect, induce) Texture (detect, induce)
Chemical	Nature	Taste (discriminate, synthesize) Smell (discriminate, synthesize)
Other types of signals coming from sensing devices or going to control devices	Nature	Velocity (linear, angular) Acceleration (linear, angular) Jerk (linear, angular) Force, torque Strain Flow rate Humidity Radiation (heat, radioactivity)

1827

KNOWLEDGE IN A COMPUTER (Input and Output of)

(Types of input and output knowledge of a computer **program**)⁵

see table above

1828

KNOWLEDGE (Law of requisite)^{1) – 2)}

"In order to adequately compensate **perturbations**, a **control** system must "know" which **action** to select from the **variety** of available **actions**" (F. HEYLIGHEN, 1992a, p.9).

F. HEYLIGHEN comments: "This principle reminds us that a **variety** of **actions** is not sufficient for effective **control**: the system must be able to (vicariously) select an appropriate one".

Such an ability seems to be basically a matter of **learning**, possibly at least at the beginning by **trial and error**. Later on, a **repertory** of adequate **responses** accumulates and the system becomes progressively abler to adapt itself to a great **variety** of **disturbances**.

The construction of the **repertory** is obtained by reducing the internal **redundancy** of the system, in accordance with the **order by noise** principle.

1829

KNOWLEDGE LOCATION (Taxonomy of)⁵⁾

T.ÖREN describes tactics and techniques of knowledge location in the intelligent **machine**, in the following way. The similarities with **brain's activity** confronted with the same problem should be usefully researched (1990, p.25).

see table next page left column

1830

KNOWLEDGE ORGANIZATION (Taxonomy of)⁵⁾

T.ÖREN proposes the following ways for organizing knowledge (1990, p.34):

see table next page middle column

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

Table: see entry **KNOWLEDGE LOCATION**
(Taxonomy of)

Criteria for discrimination	Types of knowledge location
Knowledge location without trace	Search - Breadth-first - Beam - Depth-first - Forward - Backward - Bidirectional - Pathrank order - Blind Goal-directed Data-directed - Hill-climbing - Optimal Heuristic - Best-first
Knowledge location with trace	Tracking - Backtracking - Chronological - Dependency-directed - Intelligent - Sidetracking - Tracing

1831

KNOWLEDGE (Principle of incomplete)³⁾

"The **model** embodied in a **control** system is necessarily incomplete" (F. HEYLIGHEN, 1991a, p.9).

HEYLIGHEN, who enounces this principle, sees it as a consequence of various other limitative principles which came to the fore during this century:

- W. HEISENBERG's **uncertainty principle**
- A. EINSTEIN's **relativity principle** ("of the finiteness of the speed of light", implying that the moment the **information** is registered, it is already obsolete to some extent).
- H. SIMON's principle of **bounded rationality**, "stating that a **decision** maker in a real world **situation** will never have all **information** necessary for making. an optimal **decision**"
- L. LÖFGREN's principle of the **partiality of self-reference** "implying that a system cannot represent itself completely, and hence cannot have complete **knowledge** of how its own **actions** may feed back into the **perturbations**" (p.10).

1832

KNOWLEDGE (Shared)²⁾

The basic knowledge distributed within a **network** of cooperating **elements** or **agents**.

In **networks** of **agents** endowed with such a shared knowledge – necessarily including **communication codes** - **consensual decision making** and tasks performing is possible.

As stated by M. BORILLO this applies to ergonomics or in psychosociology as well as to

Table: see entry **KNOWLEDGE ORGANIZATION**
(Taxonomy of)

Criteria for discrimination	Types of knowledge organization
Knowledge exists in one file	Ordering relations - Ordering - Partial - Linear (simple) - Well-Transfinite
Outcome of ordering	Sorting
Putting knowledge in sequence	Scheduling
With respect to time	Concurrency
Putting knowledge in groups	Synchronization
No hierarchy	Classification (assortment)
	Categorization (labeling, clustering, prioritization, Tiebreaking)
Hierarchy	Hierarchy (taxonomy) building
Knowledge exists in two files	Merging
outcome is in: one file	Merging with selection
several files	Pairing (matching)

logical and computing formulations for **simulation** of cooperative **behavior** in man or in social insects (1993, p.1129).

It is also the corner stone of the **activity** of collaborating **automata** in **networks** (see J. ERCEAU & J. FERBER, 1991).

1833

KNOWLEDGE (Tacit infrastructure of)³⁾

D. BOHM and F.D. PEAT write: "Some of our most valuable skills exist in the form of... tacit infrastructure of knowledge. A child, for example, spends long hours with a bicycle before suddenly learning to ride. Yet, once the new skill is acquired, it never seems to be forgotten" (1987, p.20).

In other words, we acquire **behavioral algorithms** and mental **autopoiesis**, by back-propagation (i.e. automatic self correction), by automatic **reinforcement** of successful **behavior** or by normative **feedback**.

This is somehow recognized even by J.J. GIBSON, who writes: "Knowledge of the **environment**, surely, develops as **perception** develops, extends as the **observers** travel, gets finer as they know to scrutinize, gets longer as they apprehend more **events**, gets fuller as they see more **objects**, and gets rich as they notice more **affordances**" (1986, p.153).

In short, it becomes better as we enrich – and learn how to enrich – our sensorially ob-

Table: see entry **KNOWLEDGE SELECTION**
(Taxonomy of)

Criteria for discrimination	Types of knowledge selection
Selection without conflict	Decision (single or multi-criteria)
Based on value-free criteria	Value-free decision Description - Interpretation - Explanation - Deductive explanation - Statistic generalization - Teleological explanation - Motivational explanation - Functional explanation - Genetic explanation Prediction Data-directed prediction Scenario writing Trend projection Model-directed prediction Delphi technique Simulation - Quantitative - Qualitative Growth analogy - Correlation Normative decision
By data-directed technique	Evaluation
By deductive inference	Prescription
By trend extrapolation	
By model-directed technique	Agreement
Model used implicitly	Resolution
Model used explicitly	Settlement
	Consensus
	Mediation
	Negotiation
	Confidence building
Based on normative criteria	
Selection with conflict	

tained **data**. Knowledge becomes in this way a capacity for recognizing **similarities** with that which one is already equipped to recognize, and a capacity to blow up accordingly the **autopoietic frames of reference** from inside out.
→ **Knowledge (Implicit)**

1834

KNOWLEDGE (Taxonomy of Factual)⁵⁾

T. ÖREN proposes the following taxonomy (1990, p.18) *see table next page left column*

See hereafter ÖREN's further taxonomies of knowledge generation, acquisition, location, analysis, selection, evaluation, organization, transformation and dissemination.

The whole set is a quite complete credo for specialists in computer operation on collected **data** and **information**, which may in effect generate knowledge *in thinking brains*.

Criteria for discrimination Types of factual knowledge

Sources of knowledge
 An existing system
 An hypothetical system
 A system that will exist
 A model

Real-world knowledge
 Hypothetical knowledge
 Design specification
 Behavior of a model

Experimental evidence for knowledge
 Observed knowledge
 Real-world knowledge
 Simulated knowledge
 Inferred knowledge
 Asserted knowledge
 Conjectured knowledge

Truth value of knowledge
 Knowledge
 Hypothesis
 Belief

Scope of knowledge
 Specific knowledge - fact
 Numerical fact
 Nonnumerical fact
 Attribute
 Relationship
 Universal knowledge
 Rule (conditional fact)
 Principle
 Law
 Axiom

Time indexation of knowledge

Knowledge is given as a time-indexed sequence of values of variables structures of a system or a model

Trajectory behavior
 Structural behavior

No time indexation Point behavior

1835

KNOWLEDGE (Taxonomy of the ways of generation, representation and processing of)²⁾

T.ÖREN did elaborate a general taxonomy of knowledge representation and processing (1990, p.1-55).

His general focus is on **informatics** and computer processing and his vocabulary is, accordingly, more or less specialized. This terminology should be carefully evaluated in comparison with its commonly accepted **meanings**.

Moreover his concept of knowledge is very close to the concept of **information** and quite close to the **meaning** given to the word "knowledge" in **expert systems**. This is practically in frontal contradiction with H.von FOERSTER's view: Knowledge is *not* a commodity.

However, it is also interesting to ponder ÖREN's ideas from various different viewpoints, as for example:

- Similarities and differences between natural and **artificial intelligence**;
- **Brain organization** and neuro-chemistry;
- Artificial and natural **neural nets** and **connection machines**;
- **Learning processes**;

Here is a list of ÖREN's taxonomic tables, reproduced, in *logical* order:

Taxonomy of:

- factual knowledge
 - knowledge generation
 - knowledge acquisition
 - knowledge location
 - knowledge analysis
 - knowledge selection
 - knowledge evaluation
 - knowledge organization
 - knowledge transformation
 - knowledge generation by experimental techniques
 - knowledge generation by nonexperimental techniques
 - knowledge dissemination
- See also:
- **Program** (rules for input and output of knowledge in a computer)
 - Knowledge (A pragmatic and operative view)
 - **Transducer**
 - **Machine-learning system** (Elements and basic functions of)

1836

KNOWLEDGE SELECTION (Taxonomy of)⁵⁾

T.ÖREN establishes this taxonomy as follows: (1990, p.28).

see table page 329 right column

One wonders about *value-free criteria*. Does such thing really exist? Moreover, which are the **criteria** to establish **criteria**? However, this general taxonomy of **selection modes** represents an important advance, compared with the naïve ways frequently observed in practice

ÖREN himself observes in relation to **value free decisions** that "since **observations** and inferences can be erroneous, **descriptions** have to be selective and must rely on interpretations." (p.29)

In other words, no **decision** is perfectly objective and "aseptical".

1837

KNOWLEDGE TRANSFORMATION (A taxonomy of)⁵⁾

T.ÖREN **classification** of the various possible transformations of knowledge is as follows (1990, p.35)

see table right column below

1838

KNOWLEDGE UNIT²⁾⁵⁾

M. KALAIDJIEVA describes as follows the "knowledge" (2001, p. 12)

"A knowledge unit (KU) in the **context** of generating new scientific knowledge is a piece of text in natural **language** presenting a novelty-invented new, or old but modified knowledge- precisely enough to communicate it to other individuals, compact enough to fit in a volume like precisely abstracts of scientific articles, or volume of reports, as it is usual nowadays, independent of context relatively to intro-

Table: see entry KNOWLEDGE TRANSFORMATION (A taxonomy of)

Criteria for discrimination	Types of knowledge transformation
Change the representation	Reformatting Decoding Encoding
Change the scope Increase within: the same domain	Rescoping Elaboration Generalization Descriptive Conjunctive
several domains	Abstraction Association
Decrease	Specialization (scope reduction)
without alteration	Focusing Attention focusing
with alteration	Simplification Pruning Condensing (summarizing)
Modify	Tuning Refinement

ductory **descriptions**, explanatory repeating of former **limits** of knowledge or surveys, details of proof with or without formulae, pictures, tables, etc".

1839

KNOWLEDGE UNIT (Methodological scientific)²⁾⁵⁾

M. KALAIDJIEVA writes (2001, p. 120)

A methodological scientific knowledge unit (MESKU) is a knowledge unit directly involved in technology of generating new knowledge and comprises statement(s) of new problem(s), experiment(s), hypotheses, law(s), **concept**(ion)(s), invented **methods** and **tools** and some other less significant like **description** of the problem **situation**, subject of research interest, etc.

1840

KNOWLEDGE UNIT (Multimedia)²⁾⁵⁾

M. KALAIDJIEVA writes (2001, p. 120)

"A multimedia knowledge unit in the **context** of **management**, innovation, research and **education** involvement is any human knowledge presentation, as details of **description**, proof, formulae, tables, sound, picture or drawing, etc. It has the quality of novelty, if it was designed for the first time by somebody"

1841

KOLMOGOROV COMPLEXITY

→ **Complexity (Algorithmic)**

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

1842

KONDRATIEFF CYCLE²⁾ - 5)

A more or less **cyclical evolution** of about 50 to 60 years discovered in economy by N.D. KONDRATIEFF.

This Russian economist published several papers on the topic from 1922 to 1928. The reality of the KONDRATIEFF **oscillation** seems now well established, even if there is some **fuzziness** about the **phenomenon**.

The subject has been reviewed recently by K. DE GREENE, who writes:

"The following would appear to be, systems theoretically, the necessary and sufficient conditions for the generation of the KONDRATIEFF phenomenon:

"1) The older system-field evolves or is driven **far-from-equilibrium** into a **domain of instability** (e.g. by overproduction of capital), and powerful forces try to restore the system to **equilibrium**. Temporary **steady-state** is lost.

"2. At **critical distance of levels**, system **evolution** may bifurcate along alternate pathways (e.g. toward a stock market crash).

"3. **Fluctuations** or mutations stochastically may occur (e.g. an emerging **paradigm of knowledge** or a technical invention).

"4 **Deterministic nonlinear interaction laws** permit **positive-feedback-mediated autocatalytic** and cross-catalytic **growth of fluctuations** into **nucleations** (e.g. an optimistic **group** in a **population**)

"5. The large **sociotechnical system** or **environment** attempts to damp the **growth of the nucleation**, and **conflict** arises (e.g. between older and newer way of organizing work)

"6. The **nucleation** triumphs, and system **evolution bifurcates** along its pathway, producing a new, irreversible **self-organization** that takes over the qualitatively changed system-field (e.g. a new **dominant technology**).

"7. **Processes** 1-6 repeat themselves, producing cascades of **bifurcations** and **structural changes** (e.g. technological **change** impacting **organization design**, in turn impacting economic **growth**)" (1988, p.291).

DE GREENE gives also a more formal interpretation of the KONDRATIEFF phenomenon and writes: "With certain simplifying assumptions (e.g. with regard to potential **functions**), **systems dynamics** and **catastrophe theory** can fit nicely into the broader framework of **dissipative structure theory**" (p.292).

see figure below

Another author who extensively researched the **long-waves** subject in economy and other fields is F. MEYER (1954 and 1974).

The KONDRATIEFF quasi-cycle seems to be an **envelope curve** for **cycles** of lesser **periods**. In DE GREENE's words: "The economic long **wave** (my "Kondratieff **cycle-structure**") is an **order parameter**" (1994, p.13). Its imperfect regularity reflects probably somewhat conflicting **determinisms** of various factors which act simultaneously and produce a global **chaotic determinism** that does not anyway become **dominant**.

DE GREENE also considers the possibility to develop a theory of KONDRATIEFF **waveforms** as **dissipative structures**, in accordance with PRIGOGINE's opinion that all **self-organizing systems** go through **cycles** of becoming, growing, changing and decaying (see G. NICOLIS & I. PRIGOGINE, 1977).

For a review of **forecasting** in KONDRATIEFF's cycle terms, see K. DE GREENE (1993, p.41-55).

An intriguing possibility would be the existence of a similar (or still longer **period**) **cycle** in the **evolution of ecosystems** and **social systems**. A systemic inquiry in these **fields**

could be rewarding. P. SOROKIN's now nearly forgotten (and somewhat shaky) investigations in historical **cycles** could possibly be reconsidered in such new terms.

→ **Self-similarity in the WEIERSTRASS function**.

1843

KÜPPERS MATRIXES²⁾

A series of successive and evermore complete interaction matrixes between a number of the most important systemists and cyberneticians, established by Günther KÜPPERS of Bielefeld University (Heinz von FOERSTER and Monika BRÖCKER, 2002, p. 268-69)

The matrixes impressively show the progressive **integration** of the system-cybernetics field through evermore complex and active reciprocal influences of the most innovative researchers in Physics, Chemistry, Ecology, Biology, Psychology, Information Theory, Philosophy and Systems and Cybernetics proper. They cover four successive periods: 1965-69; 1970-74; 1975-79 and 1980-83.

The matrixes are based on citations indexes. It would be important to further extend the matrixes and include new researchers for the successive subsequent periods of five years. the appearance of new people (for ex. THOM, E. LORENZ, BAK) and new concepts (**fractals**, **self organized criticality**, **apoptosis**, etc.) This is certainly a new step toward a more complete integration of the **transdisciplinary** framework.

L

1844

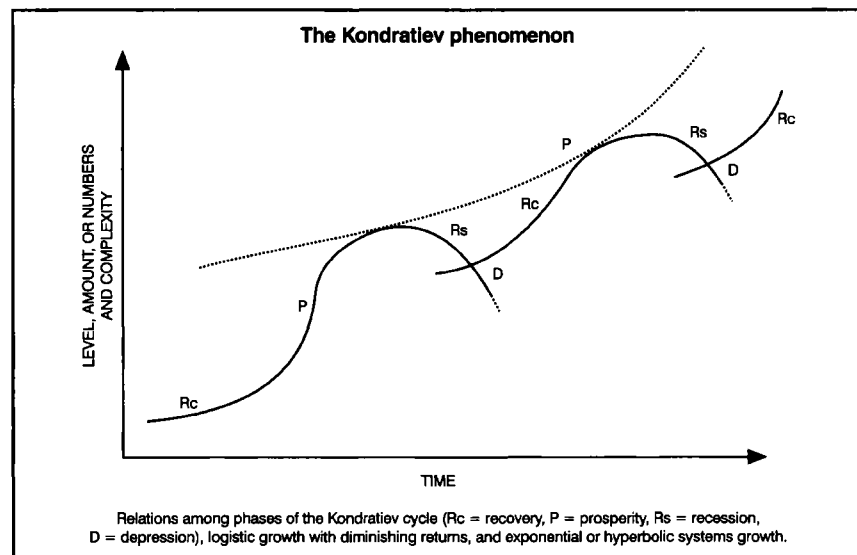
LABEL²⁾ - 3)

A symbolic device – generally spoken, written or drawn, that is used to represent something.

A. KORZYBSKI insisted much on the correct use of labels (1950). To begin with, **identification** of the thing labelled and the label should be carefully avoided. The label is not the thing and their confusion could bring very serious semantic, psycho-sociological and even practical problems. According to KORZYBSKI, the importance of the label is in its **meaning to us**, because it produces **reactions** (**semantic**, **psychological** and, in some cases, even **biological**) **in us**.

We should also take good care to avoid confusing labels of different **levels of abstraction**. KORZYBSKI showed with his **structural differential** (see Fig. p.331) that what is commonly known as an "**object**" is already a labelled **abstraction** of low level, synthesized through simplifications from the inexhaustible collection of characteristics of a "something there outside". However, the **abstraction process** does

Figure: see entry **KONDRATIEFF CYCLE**



From K. DE GREENE: 1993, p. 291

not stop there, as shown by the following example: This is "Kuki" (level 1); she is my "bas-set hound" (level 2); i.e. a "dog" (level 3); i.e. a "canine" (level 4); i.e. a "mammal" (level 5); i.e. a "vertebrate" (level 6); i.e. an "animal" (level 7); i.e. a "living being" (level 8). Every higher level covers more "objects" ... but that which is gained in generality is lost in specificity.

We finally reach the totally **abstract level** and create the label "life", open to much scientific and even ideological argument. Obviously, the whole of **systemics** is a labelling undertaking, a fact that should never be forgotten: The system is not identical to that "something there outside"

1845

LANDSCAPE²⁾

The global **space-time** wherein a system may seek better, or the best possible **fitness** conditions.

This is a more or less metaphorical **description** used by St. KAUFFMAN for the general study of the **fitness** conditions of biological systems (1993, Ch.2 to 4). He writes: "**Adaptive evolution** in real **populations** is necessarily a **search process** driven by mutation, recombination, **drift**, and **selection** over either fixed or deforming **fitness** landscapes" (p.95). However such landscapes can be mathematically modeled (p.95-120).

Landscapes can be more or less rugged, which means that a number of different **situations** can exist, offering variable **fitness** conditions. Very rugged landscapes imply separated islands of strong **stability** from which a system cannot easily escape, as it is in a nearly **frozen states**. Shallow landscapes imply the opposite conditions.

A single system is normally best adapted (**fit**) to a specific **space-time situation**, and may lose **fitness** if the **situation** changes too much for its **adaptive** capacity.

A **population** of some **class** of systems has the potentiality to globally adapt to changing **situations** by mutations and the search for better spots within the landscape.

This concept could be important for managers or leaders of **human systems**, seeking a better **understanding** of the evolving **fitness** conditions of their charge.

1846

LANDSCAPE (Epigenetic)

→ Epigenetic landscape

1847

LANGUAGE^{2) - 3) - 4)}

(Language being a very intricate concept, various definitions are given, all synthesized from numerous different sources)

1. A **set of elements** (pulses, gestures, **signs**, words, **symbols**, etc...) that can be combined through syntactical **rules** in order to form significant **associations**.

2. The **subset** of all the possible meaningful combinations that can be formed from a **set of signs**.

3. A **set of signs** with more or less commonly admitted, or coded **values** that can be used for the **communication** of **messages** between **senders** and **receivers**.

L.A. ZADEH, in turn, gives an equivalent but more formal definition: "A language *L* may be viewed as a correspondance between a **set** of terms *T* and a universe of discourse *U*" (1973b, p.33).

Any language must be a **set**, generally of quite numerous **signs**, given communicative **value** by coherent combinatory **rules**, shared by the **communicators**. As such, it can be considered a very general, extended and *open*, i.e. evolving **code**. E.von GLASERSFELD specifies that "These **signs** must be **symbols**, i.e. linked to **representations** (Symbolicity). Therefore they can be sent without reference to perceptual instances of the items they designate, and received without "triggering" a **behavioral response** in the **receiver**. As **symbols** they merely activate the connected **representation**" (1988, p.58). The word "tiger" does not normally induce an escape **reaction**, except in some quite specific **contexts**.

As to the **rules**, if they are to be **generative**, they must however introduce limitations, i.e. **constraints** to such **combinatorics**, otherwise it would not be possible to **construct** any specifically *meaningful* combinations.

The **rules** must define the **syntactic**, logical and **semantic constraints** of the language.

If these ordered **elements** are to be useful for any type of **communication**, they must be perceived and understood, in order to permit communicable **descriptions**. (H. PATTEE, 1977, p.262). This is obtained through the **coordination** of all **rules** within a **code** including their complete specifications.

P.Y. RACCAH thus describes the conditions for the understanding of which is transmitted:

"The first hypothesis postulates that the **meaning** of a sentence (or other expression of a natural language) can be described as a **set** of instructions for the possible interpreters, which state how they are supposed to *build* the significances of the possible utterances of that sentence, using their belief, **knowledge** and points of view about the **situation** of utterance. According to the second hypothesis, these instructions are concerned at least partially, with the point of view required in order to be able to interpret the possible utterances of that sentence. The third hypothesis postulates that these points of view can be described using gradual **fields** (topical fields), monotonic relations between those **fields** (topoi) and **con-**

straints of those **fields** and relations (topical **constraints**). Finally, according to the fourth hypothesis, the words of a natural language are conventionally associated to topical fields, and/or topical **constraints**; these **associations** are claimed to be responsible for the fact that the use of such or such word reflects an **ideology**, a belief or, simply, a particular **competence**" (1993, p.1245).

As to **perception**, it depends on the physiological characteristics of **senders** and **receivers**. For example, human beings do not perceive infra-red or supersonic waves, at least in a direct way, and thus cannot use them as **elements** of a language.

As to common **understanding**, it is based on the **knowledge** by **receivers** as well as **senders** of a *shared code* that must be learned: a **message**, correctly sent in Russian cannot be understood by someone who does not know Russian. This is the **meaning** of "meaningful".

The **codes** are the **syntactic rules** alluded to. They are needed to introduce **constraints** within the **set of elements**: it is obvious that not every **element** should be allowed to interconnect with every other in any **random** way, as such an undefined arrangement would be totally meaningless and could not carry any **information**. This is also the reason why the second definition considers the language as a **subset**. For example, with the latin alphabet, it is perfectly possible to construct different languages, by selecting different **rules**.

It should be taken in account, however that the **rules** may vary in time, as for example from Latin to Spanish, Italian or French.

On the other hand, as no language is a saturated **set of interconnections**, **rules** can be used as an **algorithm** for creating new combinations, corresponding to new **situations** and necessities.

In R.M. SNOW words: "Language cannot stand alone. It can only be understood in terms of a complex **relationship with action**" (1993, p.146).

Moreover, any **element** becomes **context dependent** within the language, because it can be used in quite a number of different **contexts** and, just as an atom within a molecule, acquire a **positional value**.

Ch. HENRY states it in the following way: "...language... is an aggregate of systems that taken together create an illusive, polysemous **context**. **Truth** cannot be fixed in such an **aggregate**" (1992, p.696).

As to the social character of language as a **communication** means, R. ACKOFF and F. EMERY (1972) describe it as: "A **set of signs** as well as instructions for their use such that (1) the **signs** can be produced by purposeful individuals; (2) the **signs** are semantically and pragmatically efficient for a significant portion of those who use them, (3) the **signs** are environmentally and socially general in the **seman-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

tic and pragmatic sense and, (4) the instructions signify ways of permuting and combining **signs** in the **set** to form **sign** complexes that also satisfy conditions (2) and (3)".

Thus, any language implies a previous consensual **process** and **transmission** by a teaching-learning **process**. Unfortunately, non-formalized languages – even common languages controlled by academies and other similar institutions – may easily be distorted by ideologic manipulations or prejudices.

Systemists should thus take a clear conscience of the frequent lack of **transparency** of languages.

PRIGOGINE made the interesting suggestion that language as a cooperative device between **groups** may be considered as a tool for **communication** in the same sense as, for example **chemotaxis** in amoebas and social insects.

As to D. BOHM and F.D. PEAT, they describe language as "... an **enfolded order**". Cultures and **epistemic communities** produce and reproduce the **meanings** which are "... enfolded in the **structure** of the language" and "... unfold into thought, feeling and all the activities..." (1987, p.185).

1848

LANGUAGE (Acquisition of) ^{1) – 3)}

According to N. CHOMSKY: "The person who has acquired the **knowledge** of a **language** has internalized a system of **rules** that relate sound and **meaning** in a particular way... Evidently, **knowledge** of language – the internalized system of **rules** – is only one of the many factors that determinate how an utterance will be used or understood in a particular **situation**" (1969, p.23).

About the **process** of internalization, H. ATLAN states, more precisely: "...acquisition of language (can be) seen as a **self-organizing system**. The older stages or first steps in the **process** appear as **states** of indifferentiation, with high **redundancy** in the sense that many different **signs** and **symbols** are equivalent because they have vague, overlapping **meanings**. It is only at later stages that the language has become more diversified, more differentiated, as a result of a reduction in **redundancy** such that every **sign** becomes different in a different specific way.

"Therefore a **semantic** unambiguous **content** is not to be found at the beginning of the **process** as some property to be added to, or part of, built in syntactic **structures**, but rather at the end of the **process**; starting from a non specific, **polysemic** and to same extend pre-syntactic **structure**, ending as a strictly defined **syntax**, while completely non **ambiguous meaning** as in artificial logico-mathematical language".

"From this point of view the evolution of the **semantic** component of language is not seen as an acquisition of **polysemic** and **metaphorical meaning**, starting from well defined literal, nonambiguous **meaning**, but just the opposite." (1972, p.245).

However, an important degree of **polysemy** subsists in any non formal language at the individual **level**, and most necessarily at the social **level**. Any creative elaboration of new information depends on it.

From another viewpoint, it should be observed that: "... the acquisition of language is not the result of an organized **instruction**, but takes place just by immersion in the **environment**" (A. CLEREMANS, 2000, p.84). Of course, the author means "the social **environment**". This explains the frequently poor results obtained by any teaching **method** which does not includes such immersion... as well as the basic acquisition of the mother language without any schooling at all, as a fundamental, but also automatic part of the general **socialization process**. It is a kind of systemic **conditioning**.

1849

LANGUAGE and CULTURE ^{1) – 3) – 4)}

Language is a cultural **whole**, i.e. is the indispensable carrier of **values** and **norms** in any human **group**.

Moreover, language is a system in its own right. The study of the **structures** of languages, starting with F.de SAUSSURE may even be considered as one of the oldest roots of **systemics**.

The linguistic system is different in different human **groups** and contributes to maintain and even to deepen cultural differentiation, as it is transmitted, transformed and reconstructed through generations of users.

In KORZYBSKI's terms, **time binding** is accomplished mainly by language use.

On the other hand, as emphasized by B. L. WHORF, every language bears significances proper to the **community** that evolved it. In his words, there is a: "... give and take between language and culture" (1972, p.143) whose effects he retraces in very different languages. This explains why, as said in Italian: "Traduttore, traditore".

In a still more general way, D. BOHM and F.D. PEAT: "...argue that the whole area of **perception** and **communication** must be considered as an indivisible **whole**" (1987, p.142).

Similar comments about the problems of translation which result from crossing cultural barriers have been made by A.L. BECKER in his study of Burmese language and even script (1995)

Generally, only a good **knowledge** of other languages (specially for Westerners, of non-western ones) may lead to "defamiliarization" and the **recognition** of one's own biases.

And only this kind of jumping cross-cultural frontiers could help to end intercultural misunderstanding and distrust.

→ **Semantics; Semiotics; Weltanschauung**

1850

LANGUAGE COMPETENCE ^{1) – 4)}

"The ability of an individual to transfer the **concept-components** of his own **memory** (by copying it with varying fidelity) into the **memory space** of another individual through language" (V CSANYI, 1993, p.266).

CSANYI comments: "This copying **process** is **replication**, that is the propagation of the **concept-components** in a physical sense" (Ibid).

A material or energetic carrier is necessary, as well as a modulating **code**. Moreover capacity of correct **transmission** and reception must be shared by senders and receivers, i.e., for instance, their being able to read and have a common **knowledge** of English.

CSANYI signals an overall important consequence: "... the **evolution** of concepts is not restricted anymore by the longevity of the individual. Individuals living in a linguistic **community** join their **memory space** and create a common replicative **space** with many orders of magnitude larger than the individual ones. With this new mode of **concept replication** a new evolutionary **process**, culture commences" (Ibid).

These views are akin to KORZYBSKI's "**time binding**".

1851

LANGUAGE (Digital or Analogic) ⁵⁾

Communication languages can be digital or analogic.

According to A. WILDEN: "**Digital communication**, which depends on the combination of discrete and **discontinuous elements** that can be generally considered as arbitrary **signs**, has more logical **complexity** -but less **semantic wealth-** than **analogic communication**" (1972, p.48).

Indeed, **digital** language corresponds to the pure logical formalism of BOOLE's **binary algebra** (1952) and concerns itself basically with **communication** techniques, but not with **semantics**.

Compare with the concepts of "**metron**" and "**logon**" of D. GABOR and D.M. MacKAY, with K. STEINBUCH's **learning matrixes** and A. KORZYBSKI's **structural differential**.

1852

LANGUAGE (Formal) ²⁾

A language connecting a **set X** of basic **elements** or **symbols** and a set **G** of **rules** that organize them.

Formal languages eliminate imprecise statements and permit a rigorous **organization of knowledge**. They allow the construction of **abstract systems** applicable to the establishment of coherent **models of concrete systems**.

However, the selection of the **elements** or **symbols** and of the **rules** are still the responsibility of the **modeler**.

1853

LANGUAGE (Internal and External) ^{1) - 4)}

J. PLATT states (as cited by ALLEN and STARR - 1982, p.86): "In general the internal language of a system is never the same as its external language to the **environment** or to other systems".

ALLEN and STARR give some biological examples of this, but such differences between internal and external languages are possibly still more obvious in the cases of institutional systems (e.g. the judicial system), economic ones (enterprises) or political and cultural ones (e.g. the Catholic Church, Japanese society).

1854

LANGUAGE (Visual) ¹⁾⁴⁾

A language made of **images** whose **meaning** does not depend of any specific linguistic or cultural **context**.

Such a language of universal acceptance and **understanding** is mainly a result of the swift **growth** of a worldwide **communication network** based on **technology**.

It includes **ideograms** indicating for example telephones, restaurants, rest rooms, baggage rooms or booths, **information** stands, medical help, etc... in airports and railways stations. Roads signs indicating crossroads, curves, railways crossings, entries and exits, one-way traffic, parking lots, etc... are other ideograms. In many cases, arrows or flashing **signs** are used.

Other conventional **signs** representing for example some currencies (dollars, yens, pounds, euros), many times completed by small flags, are now widely used and recognized.

Still other **signs** are widely used in electrical artifacts and **networks** and in **storage** and transportation of dangerous products.

Moreover, a growing number of private concerns are slowly imposing their own brand images or logotypes: Special foods, or credit cards, for instance.

Another **domain** wherein this visual language is growing apace is the **representation** of systems or their **parts** by, for example, **graphs**, figures, drawings, or **flow charts**.

The appearance of such a universal language is doubtless part of the construction of a world system at a higher **complexity level**.

1855

LANGUAGES (Hierarchy of) ^{1) - 3)}

In relation to WITTGENSTEIN's, TARSKI's and GÖDEL's logical investigations, and in B. RUSSELL's words: "... every language has, as Mr. WITTGENSTEIN says, a **structure** concerning which, *in the language*, nothing can be said, but that there may be another language dealing with the **structure** of the first language, and having itself a new **structure**, and that to this hierarchy of languages, there may be no limit" (quoted by L. LÖFGREN, 1979, p.247).

This is obviously also related to B. RUSSELL and A. N. WHITEHEAD's **theory of types** and GÖDEL's **Incompleteness theorem**.

1856

LANGUAGES: Special and common ^{1) - 3) - 4)}

J. ENGELBERG makes the following comment: "Every area of specialization possesses a special language. Its existence magnifies the **efficiency** and power of thought and **communication** within that area; however it also isolates practitioners of various fields from one another, and from non-specialists as well.

"By contrast, the language of integrative study is the common language... This language seems to have been devised precisely to meet the needs of the realm of **wholes**, the realm in which every person ultimately has to live. It is reasonable to assume that natural language evolved to facilitate **integration**" (1991, p.11).

Unfortunately, even the cybernetic-systemic language tends to specialize, and we should try to limit this tendency as much as possible by using an absolute minimum of specific vocabulary (and still less, jargon) and create it in the most simple terms, in order to remain comprehensible for any specialist, and also for common people.

1857

LATENCY ^{1) - 2)}

The **situation** in which some **process** remains potential during a more or less long span of **time**.

According to the nature of the system, latency can be on quite different **time scales**. The most dangerous latent **events** are those that result from a very slow **accumulation** of the **trigger** factor. This is the case, for ex. of earthquakes, volcanic eruptions, markets crashes and probably social and political sudden and violent upheavels.

Latency is a very important - sometimes quite **critical** - and in many cases overlooked condition in many **complex systems**. Latent **processes** or **events** may or may not be predictable. Their **forecast** depends on the **knowledge** of the **systems dynamics**, which

in turn depends on its strictly **deterministic** or on the contrary, **chaotic** character.

Compare with "**dormancy**".

1858

LATENCY RATIO ^{2) - 5)}

The proportion of the latent **resources** in relation to the total ones.

This **concept** was introduced by St. BEER, in "The Brain of the Firm" (1972).

This author shows the necessity of maintaining a sufficient **level** of free **resources**, that could be mobilized in case of urgency.

It is always possible to boast the productivity of a system during a limited period of **time** by using some **resource** which should normally remain reserved for **regulation** of possible internal or external **disturbances**. **Overburdening** equipment or some other critical **subsystem**, reducing or suppressing **maintenance**, depleting financial **reserves**, etc... are such questionable ways.

These dangerous **management** practice may lead to progressive shrinking of the system or, worse, to disaster in case of an unexpected crisis.

1859

LATERAL THINKING ^{2) - 3)}

A mental technique whose goal is to unfetter the mind of too narrow focuses and consequently expand the **search space** for new viewpoints.

This technique was introduced by E.DE BONO.

1860

LATTICE ²⁾

"A partially ordered **set** closed under meets and joins" (G. BIRKHOFF, 1961, p.16).

As a concrete example, the **structures** of crystals are lattices.

Lattices can be represented by closed **graphs**, oriented or not. They are basically **entanglement structures**.

As a result they can be used in the algebraic **description** of **networks**, as shown by P.H. ROOSEN-RUNGE (1966, p.14), and in the **representation** of any organized **structure**.

1861

LAW ³⁾

"A statement, together with its qualifications, that postulates a **constraint** on the conceivable **observations** and that is not contradicted by **observations** or counter examples" (K. KRIPPENDORFF, 1986, p.43)

The 19th century science tended to consider scientific laws as kinds of absolute platonician revelations about the "nature of nature".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

KRIPPENDORFF echoes Gödelian, Popperian as well as **constructivists** viewpoints when writing: "Inasmuch as they exclude something, laws are **constructions**, not to be confused with observable **facts**". Moreover "... they are often **self-referential**" (Ibid).

It also seems difficult to think about "systemic" laws. Systemics reasons about **patterns, processes, functions, structures**, etc..., but in terms of **models, homomorphic** or, at best, **isomorphic**, to which only very few systemists, if any, seem disposed to recognize an absolute **truth value**.

1862

LAW DISCOVERY ^{2) - 3)}

H. SIMON states: "Law discovery means only find **patterns** in the **data**: whether the **pattern** will continue to hold for new **data** that are observed subsequently will be decided in the course of testing the law, not discovering it... The fact that a **process** can extract **pattern** from finite **data sets** says nothing about the predictive power of **patterns** so extracted for new **observations**. As we move from **pattern** detection to prediction, we move from the theory of discovery of **processes** to the theory of **processes** for testing laws" (1973, p.471).

G.S.theories strongly enhance our ability to discover **processes** of very general character. H. SIMON's difference between **process** discovery and laws testing parallels M. BUNGE's concepts about the need to *specify* through pertinent **data** any system that we seek to inquire by *applying* G.S.theories (see **GSTs: Epistemological evaluation**).

1863

LAW SYSTEM (Evolving) ⁴⁾⁵⁾

The Argentine barrister and systemist Ernesto GRÜN considers the different **concepts** of law corresponding to the distinct **types of human communities**, as defined during the 1996 **Fuschl Conversations**:

- In traditional communities the juridical system is based on customary or so-called common-law
- In substitutive communities dominated by some **ideology**, law is also ideologically tainted. Nazi law was based on what the party considered as "the needs of the German people"

From the communist viewpoint, law was a superstructure of economy; whether capitalist or socialist

- In learning communities, the **flexibility** and **variety** appear with the possibility of interpretation and even creative interpretation for the judges
- In evolutive learning communities, alternative ways appear for resolving **conflicts**, as for example arbitration, negotiation and **mediation**.

E. Grün can be consulted at Grun@impsat1.com.ar

1864

"LAWS": Biological and social ^{1) - 4)}

According to A. RAPOPORT, quoted by J.W. SUTHERLAND, "...we must face the fact that there are no biological or social "laws" that are direct **analogues** of the laws of motion, the law of gravity, the conservation laws of **energy** and mass, the law of increase of **entropy** in **isolated systems**, etc. At most, there are *models* of specific biological or social **phenomena**, expressible as mathematical formulae to serve as working hypotheses" (1973, p.25).

This is altogether true for so-called "systemic" laws which, if possible to enounce, would refer only to totally abstract **models** of systems.

It should be added that, generally these **models** are based in new mathematical tools as for example **input-output matrixes, graphs, fuzzy sets, "catastrophes", fractals**, etc. These **models** are basically **non-linear**, generally structural and/or dynamic, and aim at the **representation** of **interactions**, global **form** and complex **transformations**.

1865

LAWS of FORM ³⁾

→ **Form (Laws of)**

1866

LAWS or MODELS ? ³⁾

According to the preceeding comments by A. RAPOPORT, we should not confuse laws with **models**: "If it happens that several **phenomena** of widely different content can be described by the same mathematical model, both simplification and generalization have been effected. Therein lies the power of mathematical **general systems theory**" (1972, p.24).

1867

LAYER ^{1) - 2)}

The **level** of **decision complexity** in a **hierarchical system**.

→ **Level**

1868

LE CHATELIER (Principle of) ⁵⁾

"Every system in chemical **equilibrium**, under the influence of a **change** of any single one of the factors of **equilibrium**, undergoes a **transformation** in such direction that, if this **transformation** took place alone, it would produce a **change** in the opposite direction of the factor in question".

More generally, in A. BOGDANOV's terms: "... systems which are in a **state of equilibrium** tend to preserve it by producing internal opposition to forces changing it" (1980, p.54). This

way to put it opens the possibility to generalize the Principle to biological systems. BOGDANOV himself states that the principle is in reality **tektological** (i.e. systemic), or universal: "an expression of **structural stability**". He reformulates the same idea, writing: "A system of (*sic*) **equilibrium** will be called such if it maintains a given **structure** in a given **environment**" (p.112).

In physical systems, the factors of **equilibrium** are temperature, pressure, and electromotive force, corresponding to three forms of **energy** – heat, electricity and mechanical **energy**.

There is already a kind of **adaptiveness** in chemical and pre-biotic systems: a succession of such **changes** and subsequent **transformations** seems conducive to **cybernetic feedbacks** and to the **dynamic stability** that characterizes **living systems**.

One should however be careful. A. LOTKA for instance observed: "... the thermodynamic justification, at any rate in the form commonly presented (Note: in 1924, before Prigoginian **thermodynamics of systems faraway from equilibrium**), does not extend to **steady states** maintained with constant **dissipation of energy**" (1956, p.286).

A generalization of the principle in systemic terms could read: "A system tends to modify itself in order to minimize any external **perturbation**".

However some caveats should be taken into account, in the case of **complex systems**, in which the **adaptation process**:

- 1) depends upon the **activity** of internal **regulators**,... themselves frequently interconnected in quite a complex way;
- 2) is practically uninterrupted, due to the repetition... or permanence of the **interactions** with the **environment**;
- 3) revolves *simultaneously* on various **adaptations**,... mostly through interconnected **cycles** having different **periods** and **amplitudes**.

A. LOTKA quotes the following statement (by J. LOWY, as long ago as 1911!): "If the **equilibrium** of a natural complex (system of masses, **organism**, system of ideas) is disturbed, it adapt itself to the **stimulus** (Reiz) which causes the **disturbance**, in such a manner that the said **stimulus** continually diminishes until finally the original or a new **equilibrium** is again established" (Kosmos, 1911, p.331 in LOTKA, 1956, p.283).

1869

LEAD ¹⁾

The property of a **regulator** able to evaluate the future **behavior** of the system and to activate the necessary corrective **action**.

Such ability depends of the **data** available to the **regulator** (about the system itself and about its possible **interactions** with its **environment**), in accordance with the CONANT – ASHBY principle that a good **regulator** must include a reliable **model** of the system it regulates.

The lead should compensate the normal **lag** in a **feedback loop** whose corrective **action** merely *follows* the registered **difference** between the prescribed and the observed **state** of the regulated **process** in the system.

Such lagging **feedback** may be unable to correct **divergences** in due **time** and may even help throwing the **process** or system out of its **stability range**.

1870

LEARNING^{1) - 4)}

1. "The **process** of acquiring **knowledge** and skills through practice, study or **information**" (UNESCO-UNEP Glossary, 1983, p.17).
2. "The general class of **processes** by which the **behavior** of an animal comes to depend not only of the **environmental changes** immediately preceding it in **time**, but also on **events** which have occurred in the related **parts** of the **environment** in the more remote past" (J.W. PRINGLE, 1956, p.93).
3. "The retention of **adaptive response patterns** for subsequent utilization, thus abbreviating the **trial and error process** (D.T. CAMPBELL, 1975, p.17).
4. "The **reduction** in the **randomness** of behavioral **elements**" (R.W. FULLER & P. PUTNAM, 1967, p.104).

These very different definitions (and many others have been given) show the complex nature of learning.

Learning is a very general ability of **living systems**. Basically it "... consists in the formation of new **neural patterns**, i.e. in establishing permanent **connections** among neurons or facilitating ephemeral (but repeatable) **interconnections** among them. Some **connections** may be formed accidentally (at **random**); if valuable, they have a **chance** of becoming established or recurrent" (M. BUNGE, 1979, p.133).

This has been demonstrated in lower **organisms** such as cockroaches or slugs. Low level learning, at least, does not even depend on the existence of the neo-cortex, nor forebrain, as mentioned by S. WALKER (1983).

PRINGLE makes an important comment to his definition: "The modification of present **behavior** by past **events** is called learning when those **events** have occurred during the lifetime of the individual, and instinct. when the **events** have occurred outside this period of **time**. In the former case the past **events** are supposed to have left some trace in the animal (usually in its nervous system), whereas in the latter case the **organization** of the animal responsible for the observed response is supposed to be in-

nate: that is to be contained fully in the material substance of its inheritance. This **distinction** is clear-cut theoretically, although great difficulty has often been experienced in assigning to one or other case the particular aspect of **behavior** which is the subject for study" (Ibid., p.74).

W.R. ASHBY stresses that "learning usually changes **behavior** from a less to a more beneficial, i.e. survival promoting, form" (1960, p.3-4).

He adds that "The nervous system is well provided with means for **action**. Glucose, oxygen and other metabolites are brought to it by the blood so that free **energy** is available abundantly... The nervous system, then, possesses almost unlimited potentialities for **action**".

But this does not explain why learning is *beneficial*: "We are concerned primarily with the question why, during learning, **behavior** changes for the better; and this question is not answered by the (*mere*) fact that a given **behavior** can change to one of lesser or greater **activity**. If a dynamic system is allowed to proceed to vigorous **action** without special precautions, the **activity** will usually lead to the destruction of the system itself" (p.4-5).

ASHBY's book "Design for a brain" is mainly trying to explain this basic question by developing a **model** of cybernetic acquisition of cerebral **organization**, with the appropriate **constraints** and **heterogeneity**.

As to FULLER and PUTNAM, they understand the learning **process** in a negative way "... rather than as the incorporation of **order** in a blank photographic plate" (p.104) and, through a **random search process** as "... the discovery of more and more **relative dominances** through interacting with (the) **environment**" (p.105).

R.L. ACKOFF stresses another important point: "Since learning can take place only when a system has a **choice** among alternative courses of **action**, only systems that are **goal-seeking** or higher can learn. If a system is repeatedly subjected to the same **environmental** or internal **change** and increases its ability to maintain its **efficiency** under this type of **change**, then it learns how to adapt. Thus **adaptation** itself can be learned" (1972).

1871

LEARNING (Action)

→ Action learning

1872

LEARNING ALGORITHM^{2) - 3)}

A **set of rules** that does not rigidly determines the **behavior** of a system, but defines the basic characteristics and limits of all its potential **behaviors**.

The learning algorithm is implicit in any **neural network** which possesses a predetermined **structure**. Such a **network** organizes itself and constructs behavioral **patterns** by **interaction** with its **environment**. These **patterns** are conserved, or evolve within the limits of the **organizational closure** proper to the **network**.

The learning algorithm is a kind of second degree **algorithm**, that is able to produce numerous simpler and more specialized **algorithms**.

It allows an "economy" which, in G. BATESON's words "... consists precisely in *not* re-examining or rediscovering the premises of **habit** every time the **habit** is used" (1967, p.245).

1873

LEARNING as a description process¹⁾

According to L. LÖFGREN: "We think of the basic **function** of our **brains** as a learning or **description process**, which produces short and communicable **descriptions** of the enormous, and in itself unmanageably complex, **data-flow** that is our direct experience of an outer world (surrounding)" (1977, p.199).

Such **brain-internalized descriptions** tend to become evermore **stable** and can thus be used as a simplification device for the synthetic interpretation of considerable chunks of outer world **data**.

In LÖFGREN's words: "Involved is the idea that the more regularities have been found, the more can be utilized (be referred to) in the **description** to make it shorter (than a lengthy listing of uncorrelated **facts**). Furthermore, the predictive power of the **description** will increase with the number of regularities found... Then more reliable **predictions** can be made on the basis of the learned **description**, and more safe **inferences** can be made of how to behave in the surrounding" (Ibid).

These views confirm that learning is a **brain process** of **algorithms** creation.

1874

LEARNING as cerebral differentiation¹⁾

In his paper: "Unidad biológica de cerebro y mente", J.M. RODRIGUEZ DELGADO (1993, p.265-6) shows that the **brain** do structure and organize itself by way of the learning **process**. The following facts can be mustered in support of such an opinion:

1. We do not remember our first infancy precisely because our **brain** had not yet created many of the **structures** needed to register most **events**.
2. Our mental faculties can express themselves only through what we have learned. DELGADO points out for example, that "Most of western people are illiterate respect to Chinese, Arabic

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

or other **languages**... because they did not learn the corresponding **reference frame**" (p.261).

3. The so-called wolf children, even when back to civilization, are very difficult to educate "because their **brain** did not receive the needed sensorial stimulations and grew up without **language**, a fact which produces grave anatomical, neuro-chemical and functional deficiencies" (p.266).

This basic fact has been thus stated by H.von FOERSTER: "I believe that the ultimate reason... systems should learn at all is that learning enables them to make inductive references. In other words, in order to enhance the chance of **survival**, the system should be able to compute future **events** from past experience".

As stated by V. ROWLAND: "...the **organization** of learning involves the development of timing within ensembles of neurons that enable the **organism**... to have the timing of all elemental **processes** brought into **coherence** with the **activity** of a total ensemble" (1976, p.124).

This **understanding** is consonant with the **autopoietic** concept of **organizational closure**. In J.L. LOCKE words: "Long before they utter a word, infants are talking *themselves* into a **language**" (1994, p.436). It seems to be a kind of **endogenous** organizational **process**, based on preexistent physiological **structures**, and on selective **interpenetration** reactions to the **perception** of external **events**.

1875

LEARNING AS SELF-REORGANIZATION ²⁾³⁾⁵⁾

R. NUMMELA CAINE and M. CAINE, centering their attention on **knowledge acquisition**, contend that: "Acquiring new natural **knowledge** fundamentally changes the way in which we perceive ourselves. In meaningful learning, the **brain** itself is reorganized, and that has consequences for the perceived self"

And: "We suggest that this **process** (of active **uncertainty**) is critical to helping the **brain** make maximum **connections**" (1994, p.137-8)

In relation to the inner **perception** of the sudden **emergence** of a new and re-arranged **understanding** (the so-called "aha" episodes), they add: "The **emergence** of the "aha" is frequently preceded by periods of **uncertainty** or **ambiguity** and hard, intrinsically motivated work requiring **delay** of other forms of gratification" (Ibid)

This is not only the case in learning but, possibly still more so in artistic and scientific **creativity**: great new **concepts** mostly seem to appear in flashes of sudden insight... duly prepared by a long period of frustrating and obscure useless **trials and errors**. Many great scientists have given their testimony on this.

→ also: **Self-reorganization**

1876

LEARNING (Back-propagation) ^{1) - 5)}

Learning seems to be basically a recurrent two stages **process** in **neural networks**, a **model** of which could be the **back-propagation algorithm** in neural computer **networks**.

According to G. HINTON "The most serious objection to **back-propagation** as a **model** of real learning is that it requires a teacher to supply the desired **output** for each training example. In contrast, people learn most things without the help of a teacher. Nobody presents us with a detailed **description** of the internal **representation** of the world that we must learn to extract from our sensory **input**." (1992, p.108).

It could be argued that **living systems** have such a "teacher", in the guise of their genetic **structure**, which allows them to start from basic physiological standards, genetically **embedded**, that can be "educated". The natural respiratory **rhythm** or the sense of **equilibrium** seem to be good examples. Learning however, to ride a bicycle is basically a self-correcting **back-propagating process**.

The general sequential learning **process** should thus be:

- put to use or establish a basic standard
- calculate the **output deviation**
- correct the **inputs** in order to obtain a better correspondance with the standards

At a more complex **level**, a **process** of correcting the standards themselves may appear, specially behavioral, conceptual or ethical ones, through ethological or cultural **interaction**.

1877

LEARNING by DOING ¹⁾

"The **process** of acquiring **understanding**, **knowledge**, skills and attitudes through practical and applied learning activities" (UNESCO-UNEP Glossary, 1983, p.17).

The following comments are added: "A relatively permanent **change** in the **behavior** (and attitudes) (is observed) as a result of the individual's experience in doing. (It involves **observations**, investigation, **inquiry**, **problem-solving**, and **value** clarification, which are effective learning methods in **environmental education** and field **situations**" (Ibid).

Learning by doing is thus a very important systemic **activity**.

1878

LEARNING by normative feedback ¹⁾

In a **net** of biological neurons, the global capacity of the **net** results from the **self-organization** of neural **connections** under the effects of the **inputs** that they receive and transmit.

L. PERSONNAZ et al. state: "The principle of this **self-organization** is simple: The **efficiency** of any synapse is reinforced when the neurons that it connects have a tendency to be active or inactive simultaneously; in the opposite case it lessens" (1988, p.1364).

This effect is strengthened locally within the strongly connected **net**, by repeated **feed-backs**.

Learning seems to be the progressive dynamic **stabilization** of **frames of reference** within the more or less narrow **limits** of a **repertoire** of stored **information**, relevant within a kind of pre-imprinted but very general **program**, while the irrelevant **data** are not retained.

See for example N. S. CLAYTON about song learning in birds (1991, p.466-72).

It could be a progressive algorithmization of **behaviors**. The upbuilding of such **algorithms** could possibly be modeled through **attractors**.

These concepts are also relevant for the new forms of **perceptrons** (recognition of more or less well written or printed types, for example).

1879

LEARNING COMMUNITY

→ **Communities (Types of Human)**

1880

LEARNING COMMUNITY (Evolutionary)

→ **Communities (Types of Human)**

1881

LEARNING (Competitive) ²⁾⁵⁾

In **parallel processing networks**, "an unsupervised learning **procedure** in which the **network** is presented with a series of **input patterns** and must discover regularities in those **patterns** that can be used to divide them into **clusters** of similar **patterns**" (Adapted from W. BECHTEL & A. ABRAHAMSEN, 1991, p.304)

The authors add that **input patterns** are selected through "inhibitory **connections** among the **detector** units to assure that just one unit will "win" the **competition** for a particular **input pattern**" (p.305).

In this way, **inputs** become classified in **categories**.

"In more complex systems there may be multiple **nets** of **detector** units, or intermediate **layers** of units" (p. 305)

Interesting **heuristic analogies** can be drawn with the ways human **brains** are learning.

1882

LEARNING (Double-Loop) ^{1) - 3)}

A learning **process** that enables the system to learn to learn.

This model has been introduced and developed mainly by W.R. ASHBY (1956) and G. BATESON (1973), who also called it "Deutero-learning" (see "Learning levels").

It implies the **emergence** of generalization **rules** of **induction**. **Systemics** is a typical double-loop learning tool.

1883

LEARNING (Evolutionary reinforcement)¹⁾

A form of individual learning that should have an influence on the **evolution** of a **group** or a species.

This hypothesis was proposed by D.H. ACKLEY (quoted by S. LEVY, 1992, p.265), who writes: "As dictated by their genetic **code**, **agents** would actually develop *two neural networks*: an "action network" that would convert sensory **input** into **behaviors**, and an "evaluation network" that would also draw from sensory **input**, by using that **information** to judge whether a particular **situation** was good or bad. Depending on the **feedback** it received after acting on that judgment, the **agent** would reinforce, or modify, its **behavior**" (1992, p.265).

It seems for example that individual **ethological adaptation** (e.g. the monkeys who learned to clean potatoes in sea salt water, in Japan), transmitted from generation to generation, modify the **ecological niche** of the species as a whole and could eventually lead to a different **selection** of **random** mutations.

ACKLEY successfully applied the idea to define a **set** of **rules** for evolving **groups** of **artificial organisms**, with positive results.

The **model** – a kind of Lamarckian transmission of acquired **behavioral patterns** – could probably be useful for the **understanding** of the way human **organizations** react to individual **adaptations** and innovations of some of their members.

1884

LEARNING (Fourth Order)²⁾

"Changes in those **processes** of change referred to in **3d order learning**" (Adapted from 1973, p.220).

According to BATESON: "Whether learning of this fourth order occurs in human beings is unknown" (Ibid).

4th order learning could probably be related to critique of **metaconcepts** formation, of the kind developed by GÖDEL, CHURCH and TURING. (see Ch. FRANÇOIS, 1987). Systemic and cybernetic **isomorphisms** could be considered as a basement for this 4th. order learning.

It should however be necessary to find a corresponding **neural networks mechanism**.

1885

LEARNING HEURISTICS (Basic)³⁾

M. MINSKY and O. SELFRIDGE (1960) proposed the following method: "In a novel **situation** try methods (**parameter** adjustment, **network organizations**) like those which have worked best in similar **situations**" (quoted by G. PASK, 1961, p.83).

This may be a quite useful **method**, but it is not very innovative.

M. MINSKY, in particular, around 1960, as a critic of F. ROSENBLATT's **perceptron**, was not optimistic about the practical possibility of evolutionary self-learning or self-organizing **networks**, which are based on loose behavioral **rules**, and not on precise and limited **algorithms**.

More recently, ways out of these difficulties have been introduced. See "Artificial Life" and "Intelligence (Distributed Artificial)".

1886

LEARNING LEVELS³⁾

G. BATESON describes a **hierarchy** of learning levels, as follows:

1. 1st order learning: The simple receipt of a **signal** within a formerly ordered **pattern**, with the corresponding triggering of an **action**.
2. 2d order learning, practically equivalent to **pattern** modification through experience or experiment.
3. 3d order learning, which implies a capacity to reform learning **processes** through reappreciation of **pattern** modification and their results, with subsequent modifications the mode of **pattern** construction.
4. 4th order learning, which is still more or less hypothetical and would imply a general **methodology** for **pattern** reconstruction and invention.

See details under specific headings.

1887

LEARNING MACHINE²⁾

"A machine capable of performing certain **actions** even though the builders do not know **algorithms** for these **actions**" (P. DENNING, 1992a, p.14).

The learning machine constructs its own **algorithm** to perform the task.

DENNING explains that it does so by adjusting "internal **parameters** of an **associative memory**", as it registers successive examples "each consisting of an **input** and a corresponding ideal" (Ibid.).

He adds: "...the machine's internal **structure** can be represented by a **set** of **rules** telling it how to respond to given **inputs**".

Moreover: "After each **action**, the machine uses the resulting pay-off **feedback** to modify its **rule set** so that an effective **behavior** is reinforced or an ineffective **behavior** is dropped".

In this way "... a **population** of **rules** evolves over **time** and the **rules** producing the highest pay-offs come to dominate the **population**". Thus "**Genetic algorithms** are being used as the builders of **programs** inside learning machines" (Ibid).

In order to be able to perform a task, a learning machine needs thus an **algorithm** producing **algorithms**, i.e. a genetic **algorithm**. Such a **meta-algorithm** must by necessity be able to produce, experiment and select combinations of basic **rules**.

The concept apply also quite probably to natural learning machines.

1888

LEARNING MATRIXES (STEINBUCH's)²⁾

A **model** of learning **processes** through a **commutative structure** represented by a matrix.

Such **models** have been proposed by the German cybernetist K. STEINBUCH. (See K. STEINBUCH, 1961; N. WIENER & J.P. SCHADE, 1963 and G. KLAUS und H. LIEBSCHER, 1976)

As in any matrix, the **structure** consists in a table connecting horizontal and vertical **elements**, in such a way as to represent stipulated **interconnections**.

The so-called "lern-matrix", which represent the process of learning proper ("Lernphase"), connects at any intersection in the matrix some property, i.e. basically a perceived characteristic, with a **meaning**, i.e. a corresponding **symbol**, verbal or otherwise. Once the matrix has been constructed, the so-called "Kannphase" (i.e. **knowledge** phase) is reached, in which it is possible to retrieve any characteristic through the corresponding **symbol**.

In general, **connection** of **meanings** with properties is the basic condition of the shaping of **semantic codes**. It is thus also the basis for the creation of **information**, as it is the **connection** that transforms **noise** into **meaning**. It implies however the **pre-existence** of a physiological **substratum** (for ex. visual **perception** or phonation capacity) through which **rules** for **connections** can be expressed. Moreover, any individual has his/her own **autopoietic closure**. As a result, **rules** may vary slightly for different individuals.

It is possible to construct learning matrixes at various interconnected **hierarchical levels** of **abstraction**. This corresponds more or less to:

- G. BATESON's **levels of learning**
- A. KORZYBSKI's **structural differential**

STEINBUCH's **models** seem to represent quite accurately the formation and subsequent uses of **representations** obtained from **perceptions**.

→ "Learning processes"

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1889

LEARNING (Observational)¹⁾

D.T. CAMPBELL describes observational learning "as characteristic of *social* animals, in which the observing animal learns from observing the outcomes to an exploring animal, and thus even profit from experience that may prove fatal to the exploring animal" (1961, p.18).

This type of **behavior** has been observed, for instance, in rats.

Social animals may also learn from the **observation** of the traces of **activity** left by other or former members of the **group** (**stigmergy**).

1890

LEARNING PROCESSES³⁾

E. JANTSCH proposed the following characterization of different learning processes, as related to **consciousness**:

"- **Virtual learning** is characteristic of non-reflective **consciousness** (sic) (JANTSCH gives examples from quantum physics and **dissipative thermodynamics**).

"- **Functional learning**, characteristic of reflexive **consciousness** or simple **perception**, may be graphically depicted by the **feedback interaction** between **consciousness** and **environment** which appear here in a **binary** link. This kind of **interaction** is found in biological and primitive social **processes**.

"- **Conscious learning**, Characteristic of self-reflective **consciousness**, may be viewed as the multiple **feedback interactions** in the ternary system formed by **consciousness**, the **environment**, and a **memory** or **storage** system which may be termed the "appreciated world" and which of course is itself part of **consciousness**...

"- **Superconscious learning** characteristic of a more complex kind of self-reflective **consciousness** which mirror itself in a "surface" **consciousness** as well as in a multilevel superconsciousness of "depth" **consciousness**..." (1976, p.41-42).

The problem with this classification is that the concept of **consciousness** is at the same time abstract and subjective. On the one side, it seems difficult to accept so-called "nonreflective **consciousness**" in physical systems (Is this not an anthropomorphic **metaphor**?). On the other hand, **consciousness** is something which happens in the nervous system (and more precisely in the cortex) and we still lack a clear **understanding** of how it is produced.

Another view on learning processes is S. GROSSBERG's (as commented by R. FISCHER, (1992, p.235):

"In GROSSBERG's adaptive **resonance** theory (1987) learning and **memory** are basically identical **processes**. Raw sense **data** from "out there" combine with the **associations** from the past and resonate until a coherent **image** is formed.... What resonates in GROSSBERG's **model** is a cloud of neurons – an **interconnected group of cells** surrounded by inter-neurons – that together form an electronic **feedback** system which resonates in **response** to a particular **class** of sensations... The functional unit of short term **memory** is a **resonating pattern** (of **synaptic weights**) that fades in about 15 seconds if not committed to long term **memory** through **association** with "remembrance of things past". The conscious experience of daily routine then, is a **pattern-matching game** between the novelties perceived and the known **patterns**".

→ **Learning matrixes**

1891

LEARNING (Reinforcement in)²⁾

The strengthening of a behavioral or mental **pattern** by the occurrence or experimental introduction of a relevant **stimulus**.

G. BATESON remarks: "The notion is that **random changes** occur, in the **brain** or elsewhere, and that the results of such **random change** are selected for **survival** by **processes** of **reinforcement** and extinction. In basic theory, creative thought has come to resemble the evolutionary **process** in its fundamentally stochastic nature".

However: "In both the theory of **evolution** and the theory of learning, ...the word '**random**' is conspicuously undefined and the word is not an easy one to define ... Underlying both the stochastic theory of **evolution** and that of learning, there are *unstated* theories regarding the determinants of the probabilities in question. If however, we ask about **change** in these determinants, we shall again be given stochastic answers, so that the word '**random**', upon which all of these explanations turn, appears to be a word whose **meaning** is hierarchically structured" (1973, p.226).

Once again, we find ourselves confronted to the basic problem of the **meaning** or our concepts. In our definition "strengthening" and "relevant" imply the existence of some former **structure**, already more or less **autopoietic**: How was it instated?

1892

LEARNING RULE (HEBB's)^{2) - 4)}

In 1949, the Canadian neurologist D. HEBB formulated the following learning rule: "When an axon of cell A... excite(s) cell B and repeatedly or persistently takes part in firing it, some **growth process** or **metabolic change** takes

place in one or both **cells** such as A's efficacy, as one of the **cells** firing B is increased" (1941).

E.R. KANDEL and R.D. HAWKINS, who quote this author, write: "According to HEBB's learning rule, coincident **activity** in the presynaptic and postsynaptic neurons is critical for strengthening the **connection** between them (a so-called pre-post associative **mechanism**)".

HEBB's rule could possibly be generalized to interpersonal and intergroupal **communication** in social systems, which are obviously **networks** in their own right.

1893

LEARNING (Second Order)^{1) - 2)}

Any **process** (in a **hierarchy** of such **processes**) which modifies an already ordered and registered significant **pattern**.

In G. BATESON's understanding, 2d order learning implies a reordering of the former **pattern**, in relation to the **emergence** of a new **signal**, or some alteration brought to the existing one. He gives the following examples of 2d order learning experiences or experiments: "Pavlovian, instrumental reward, instrumental avoidance, rote and so on" (1973, p.220).

1894

LEARNING (Systemic)^{1) - 3) - 4)}

A set of ways and means to acquire an integrated **understanding** of ourselves, our society, our **environment**, and all the significant **interrelations** which connect them.

What we need – all of us – is a **meta-knowledge**, a way to look at this complex world in all its stances and to understand what is going on and what may, possibly, happen.

Let us however not be blinded by high-sounding "**meta-knowledge**". Many of our forefathers did possess at least something of it, passed along by their cultural heritage as "popular wisdom" (fables, proverbs, myths, scriptures, etc.). These tales and sayings proposed, in a covert way, quite general interpretations for many **events**. This is precisely what our actual instructional and educational **process** does not offer anymore. Our excessively specialized and micronized **knowledge** bars us the **understanding** of global **situations**, which is precisely what we must recuperate.

We all became all-out mechanists-voluntarists easily devoid of common sense. The dominant scientific **paradigm** led us to conceive and understand everyone of our projects (material, personal or social) as a rather simple "**machine**" that we construct on the base of some **linear cause-effect** principle in order to reach some clear-cut and defined result. Most of us never doubt that such aims will be necessarily attained, just in the way we did plan our project. Nevertheless, we now have thousands of examples of precisely the opposite.

This is because we ignore, at least in our practice, **nonlinear** multiple **connections**, and have a very deficient **perception** of **time** dimensions (which leads us to unwarranted **extrapolations**).

Systemic learning should aim at the creation of a good **understanding** of every kind of **complex systems**.

Generally speaking, this suppose the intuitive and later on, the rational appreciation of their constitution, inner workings, their **transformations** and **interrelations** among themselves and with their respective **environments**.

General systemics and cybernetics offer an ever widening set of **isomorphies**, **models** and **methods** to obtain such results.

1895

LEARNING (Third Order)^{2) - 3)}

"Those learnings which constitute changes in **2d order learning**" (1973, p.220).

At this level, we already have learning to learn **processes**. Actually BATESON first proposed to call these **phenomena** "deutero-learning" and later on "trito-learning", expressions which never became firmly rooted into usage.

In a **hierarchy** of learning **processes**, 3d order learning implies the capacity to **understand** and to modify conditioning through a better appreciation of **context** and thus, up to a point, to reconstruct behavioral or mental **patterns**.

1896

LEARNING (Trial and error)¹⁾

This expression was coined by L. MORGAN in England and E.L. THORNDIKE in the United States.

W.R. ASHBY observes: "The **process** of trial and error can then be viewed from two very different points of view. On the one hand it can be regarded as simply an attempt at success; so that when it fails, we give zero mark for success. From this point of view it is merely a second rate way of getting to success. There is, however, the other point of view that gives it an altogether higher status, for the **process** may be playing the invaluable part of *gathering information*, **information** that is absolutely necessary if **adaptation** is to be successfully achieved" (1960, p.83).

The result of every trial is:

1. recorded in the **memory** of the system
2. integrated in a non-contradictory **structure** of internally organized **information** i.e. **knowledge**
3. also possibly integrated into a **repertory** of automatic **responses** or skills.

Each trial modifies the internal **state** of the system and predisposes it to a better adapted future **activity**, even if some cases some trials (followed by good or negative results) must be repeated several times.

ASHBY's own **Law of Requisite Variety** is obviously an elaboration on the usefulness for a system to enrich its **repertories** of possible **states** or **responses** to variations in its **environment**.

Learning by trial and error, as an internal ordering **process**, is also related to the **model of order from noise**.

1897

LEARNING (Types of)¹⁾

J.W.S. PRINGLE distinguished (1951) the following different ways of learning:

1. **Habituation**, which results of a repeated **reaction** to repeated **stimuli** of one specific kind. This effect may disappear if the interval between repetitions is too long.
2. **The conditioned reflex**, which associates by convenient training a **response**, at first elicited by a specific **stimulus**, to another **stimulus**.
3. **By trial and error**, in which a **response** is selected by the **subject** after a number of more or less **random actions**.
4. **Insight learning**, by which, in a new **situation**, a **response** is selected from a number of possible **responses** resulting from previous more or less similar experiences.
5. **"Imprinting"** (in birds and insects), by which the environmental **situation** at certain critical periods in the animal's lifetime becomes specially effective in producing permanent modifications of subsequent **behavior** (p.94).

PRINGLE's paper is about these various learning ways.

E. LASZLO has stretched the concept of learning in relation to the different **levels** of natural systems. His views have been resumed by E. JANTSCH as follows:

"Virtual learning is characteristic of non-reflective **consciousness**...

"Functional. learning, characteristic of reflective **consciousness**, or simple **perception**... This kind of **interaction** is found in biological and primitive social **processes**...

"Conscious learning characteristic of self-reflective **consciousness** or apperception ... the normal **mode** of learning and of becoming creative in the human social realm ...

"Superconscious learning, characteristic of a more complex kind of self-reflective **consciousness** which mirrors itself in a "surface" **consciousness** as well as in a **multilevel** superconsciousness or "depth" **consciousness** ... (It) provides a sense of direction for cultural and mankind progress by "illuminating" the **process** from the far end in terms of guiding **images**".

"These learning **modes** characterize **levels** of macroscopic coordination of interactive **processes**" (1976, p.41-42).

One only wonders if **consciousness** can exist without being reflective.

D. DUBOIS offers still another **classification** of types of learning:

"1. **Learning** as the **process** of creation of new **representations**... Ready-made **representations** can be proposed to intelligent systems who can assimilate them.

"2. **Self-learning**, the **process** through which (such systems) create themselves new **representations**.

"3. **Meta-learning** related to the learning of learning. It can be taught through **rules** that guide or channel the learning process.

"3. **Meta-self-learning** related to the intelligent system's reflexion on his/her self-learning **methods**. This is related to the **phenomenon** of **consciousness**" (1990, p.180)".

1898

LEARNING (Zero)^{2) - 3)}

"The simple receipt of **information** from an external **event**, in such a way that a similar **event** at a later (and appropriate) **time** will convey the **same information**" (G. BATESON, 1973, p.255).

This definition needs at least one qualification: Zero-learning is not independent of **context**, which, in BATESON's definition is present through the words "similar" and "appropriate". BATESON's own example indicates as much: "I learn" from the factory whistle that it is twelve o'clock". This implies:

- 1) that I have registered former experience that the factory blows the whistle every day when my watch indicates 12 o'clock;
- 2) that the factory's whistle is not blown randomly for example again 10 minutes later, which, if I have no watch, would leave me in a state of doubt as to which of the whistles really marked 12 o'clock.

1899

LEAST ACTION (Principle of)^{1) - 2)}

Motion and **change** are always achieved in a way such as the needed **action** is at the minimum.

This variation principle has its origin in celestial mechanics and mathematics. It has however been since rediscovered in quantum theory and in relativity (geodesic paths).

Least action is necessarily related to the **global fields** within which it takes place, themselves to be described in terms of **Hamiltonian systems**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

While it probably corresponds to PRIGOGINE's **Theorem of minimum entropy production**, the status of the principle in relation to **thermodynamics of irreversible systems far-from-equilibrium, dissipative structuration and deterministic chaos** does not yet seem to be clearly established.

This principle was first enounced by Pierre MOREAU de MAUPERTUIS. J. CASTI exemplifies and comments: "This action... is an abstract quantity, like **energy** but different, that depends on the **path** of the comet between a starting point and an ending point. In principle, a comet might follow any of an infinite number of different paths - it might follow a straight line, for example, or a complicated path that wriggles back and forth. Every conceivable path has a different action, and of all these, the path actually taken has the least" (J. CASTI, 1998, p.44).

One wonders if MAUPERTUIS' principle does not signal a bridge between EINSTEIN's understanding of the relation between **time** and **space** and PRIGOGINE's understanding of the relation between **time, energy, entropy** and **emergence**.

1900

LEAST EFFORT (Principle of) (ZIPF)²⁾

"A **structure** containing a **trigger** that requires more **energy** than it releases for its own use will suffer a net reduction of potential **energy**" (As quoted by R.N. ADAMS, 1988, p.53).

J.G. MILLER gives the following interpretation to the principle: "Systems which maintain **stability** over long **periods of time** apparently tend to reduce the **costs** involved in the activation of ... associated **variables**" (1978, p.35).

He also observes that ZIPF may thus "have identified a general principle of work done by **organisms**", as his principle states "that systems use least costly **adjustments** first, and more costly ones later". This has the general meaning "that systems conserve **resources** by maintaining their **subsystem functions** efficient and by keeping down **costs**".

MILLER adds that at least in the economic sense "this is **optimization** of the **organism's behavior**" (1978, p.436). The principle also seems to be related to H. SELYE **General Adaptation Syndrome**, and his concept of **stress**.

However, according to ADAMS, the principle is somewhat of an obvious statement. Yet, its consequences can be obscured in biological **organisms** or social **organizations** in which, during a long **time**, some ill functioning **parts** are in condition to use **resources** obtained from other **parts** or **subsystems**. If such a squandering **process** is not reversed in due time the final **breakdown** becomes unavoidable.

1901

LEAST EFFORT PRINCIPLE (St. UMPLEBY)^{1) - 2)}

"An **adaptive** system will try either adapt to its **environment** or adapt that **environment** to its needs, whichever is easier" (As quoted by K. KRIPPENDORFF, 1986, p.59).

While this could be a consequence of ZIPF's Principle, it is however quite a different one.

Systematic efforts to adapt the **environment** to their needs is basically a recent characteristic of **socio-technical human systems**, with the possible older example of insect societies.

The concept may also be related to the **co-evolution** one, in which the **environment** is basically another specific system.

1902

LEVEL²⁾

"a) A section of a **hierarchy** which is defined by a **scale**".

"b) The **scale** of an **observation**" (T.F.H. ALLEN & T.B. STARR, 1982, p.271).

M. BUNGE emphasizes that ... "a level is not a thing but a **set** and therefore a concept, though not an idle one. Hence levels cannot act upon on another... All talk of interlevel **action** is elliptical or metaphorical, not literal" (1979, p.13). Formerly, BUNGE also wrote: "A level is a section of reality characterized by a **set** of interlocked properties and **laws**, some of which are peculiar to the given **domain**, and which are assumed to have emerged in **time** from other (lower or higher) levels existing previously" ("Metascientific queries", 1959, p.8).

M. MESAROVIC, D. MACKO and Y. TAKAHARA introduce three different notions of level: "1) the level of **description** or **abstraction**; 2) the level of **decision complexity**, and 3) the **organizational** level. To distinguish between these notions, we use the terms "**strata**", "**layers**" and "**echelons**" respectively. The term "level" is reserved as a generic term referring to any of these notions when there is no need to emphasize the **distinction**. We point out that, in the **description** of an actual **hierarchical system**, all three notions might be involved; the case where only one notion is applicable is an exception rather than the rule" (1970, p.37).

ALLEN and STARR state: "Many different entities may be observed scaled to a certain level distributed horizontally across a **hierarchy**" (p.271).

Complex systems are necessarily multi-leveled, as the harmony of their different **subsystems** requires the shaping of **hierarchic controls** or distributed and interconnected **regulations**, and each **subsystem** is in turn made of **elements** or **parts** and acts as their coordinator.

F.E. EMERY states that "in analysis of any one level of a system's **organization** it probably would be adequate to consider only the ones immediately above and below" (1969, p.15).

1903

LEVEL (Dominant)^{1) - 2)}

In a **hierarchized** system, the level at which some **control** operates on **elements** or **subsystems** at lesser levels.

Any **regulator** is at a dominant level in relation to that which it regulates. However, to perform correctly its **function**, it needs **information inputs** from the down level, or levels.

1904

LEVEL (in Forrester's Systems Dynamics)²⁾

The **state** or condition of the system or any of its **subsystems** at a given instant. In this context, levels are expressed quantitatively.

1905

LEVEL (Natural)²⁾

"A level identifying entities which are robust under **transformation**." (T.F.H. ALLEN & T.B. STARR, 1982, p.273).

1906

LEVEL OF RESOLUTION²⁾

"The grain **size** of an **observation** as limited by the finest **distinction** which can be made given the **observation filter**." (T.F.H. ALLEN & T.B. STARR, 1982, p.271).

ALLEN and STARR add: "In a broader sense, level of resolution includes consideration of the scope of the investigation which determines the most coarse-grained aspects of the **phenomenon** that may be recognized." (Ibid.).

1907

LEVEL (Phenomenological)^{1) - 3)}

An **observation** level directed at a **complex system**, corresponding to a clearly identifiable organizational level.

Even the global study of a system as a **whole** requires a certain degree of analytical decomposition, without which only tautological pronouncements of the type "The system is what it is or does what it does" could be produced.

The determination of any phenomenological level is unavoidably a complex compromise between the postulate of the existence of a "**concrete system**", the perceptive ability of the **observer** (with or without instrumental implements), his/her viewpoint, conceptual postulates and the practical **goals** pursued.

The phenomenological level is however by necessity the one of "direct experience, encompassing **perception** of outside things", according to J.W. SUTHERLAND, who adds, perhaps somewhat more questionably "feeling, thinking, willing, etc. (1973, p.55).

This last perceptive setting may possibly be somewhat too subjective, but is partially compensated by debate among **observers** and by the resulting **process** of **consensus**, still subject, of course, to the possibility of errors, collective biases or illusions.

1908

LEVELING MECHANISMS²⁾⁴⁾⁵⁾

This concept has been introduced by the ethologist Fr.De WAAL and is thus inspired by his observations of the way animals living in groups manage their rivalries. (2001, p. 102-107)

It seems however to be of general value.

Leveling mechanisms are indeed an absolute need in systems wherein strong tensions appear during **interactions** among **elements** or **subsystems**.

They are basically countervailing **feedbacks** acting in reaction to incipient disbalances (which can be automatically registered or psychologically perceived)

Without levelling mechanisms, uncontrolled **fluctuations** become unavoidable and, as they carry the system out of its **limits** of **dynamic stability**, can finally destroy it.

→ **Adaptability; General adaptation syndrome; Homeostasis; Interoception; Stress**

1909

LEVELS (Integrative)²⁾

A theory of Integrative Levels was summarized by J. K FEIBLEMAN as early as 1954 (1954, p.59-66), as a synthesis from previous work by K.L.von BERTALANFFY, J.H. WOODGER and A.B. NOVIKOFF.

FEIBLEMAN stated the following laws of levels:

1. Each level organizes the level or levels below it plus one **emergent** quality.
2. **Complexity** of the levels increases upward.
3. In any **organization** the higher level depends upon the lower.
4. In any **organization** the lower level is directed by the higher.
5. For any **organization** at any given level, its **mechanism** lies at the level below and its **purpose** at the level above.
6. A **disturbance** introduced into an **organization** at any one level reverberates at all the levels it covers
7. The time required for a change in **organization** shortens as we ascend the levels.
8. The higher the level, the smaller its **population** of instances.

9. It is impossible to reduce the higher level to the lower.

10. An **organization** at any level is a distortion of the level below.

11. **Events** at any given level affect **organizations** at other levels.

12. Whatever is affected as an **organization** has some **effects** as an **organization**.

To these characteristics, FEIBLEMAN added some significant **rules** of explanation related to levels of integration:

1. The reference of any **organization** must be at the lowest level which will provide sufficient **explanation**.
2. The reference of any **organization** must be to the highest level which the **explanation** requires. (FEIBLEMAN adds the following and significant comment: "The lowest levels are complex enough to make **explanation** a difficult affair, but over-**simplification** does not explain: it explains away" (p.64)
3. An **organization** belongs to its highest level.
4. Every **organization** must be explained finally on its own level.
5. No **organization** can be explained entirely in terms of a lower of higher level.

FEIBLEMAN's is a very seminal paper. Some of his **concepts** on levels have been rediscovered, and extended, later on - possibly without knowledge of his work - by other authors as for example:

- K. BOULDING with his **8 levels of complexity**
- J. MILLER, with his **taxonomy of living systems**.
- H. SABELLI who in his **process theory** emphasizes the "**priority of the simple**" and the "**supremacy of the complex**".
- H. SIMON with his "**Architecture of complexity**".
- J.van GIGCH with his theory of **metasystems**.

1910

LEVEL-SPECIFIC PRINCIPLES²⁾³⁾

Our study of nature led us to the discovery - quite recent - that no level of **complexity** can be totally understood at the lower **levels**.

In P. ANDERSON's words: " Psychology is not applied Biology, nor is Biology applied Chemistry" (1972)

To cross from one level to a more complex one we need in each case a principle that prescribes a specific way of **organization** at that level.

For example the organization of the **cell** cannot be explained merely by the **rules** of chemical valencies resumed in MENDELEIEV's periodic table of elements.

However principles at each level seem to be somehow intertwined in a more general principle of **complexification** as for example P. CORNING's **synergetic** hypothesis, or HAKEN's **power laws** or **slaving principle**, or van GIGCH's recursive **meta-control**.

In one or another way similar principles are to be found in all of the disciplines which study more or less organized **complexity**, as for example **ecology** or climatology.

1911

LIFE CYCLE

→ **Cycle (Life)**

1912

LIFE TIME¹⁾

The span of survival of a **component** in a system or **subsystem**.

According to R. ROSEN, in an arbitrary system M "... each **component** M_i of M has a finite life-time which we shall denote by u_i ; by this we mean that, after M_i has been in **operation** for an interval of **time** u_i it shall cease to function." (1974b, p.31).

This is a very general property of **components** in **complex systems** (**living systems** and **organizations**, and in an analogous way, **machines**). The replacement of **components** by other **components** of the same type is an absolute necessity for these systems and is done in **living systems** through **hypercycles** and **organizational closure**.

In order to obtain some predictive power about the life time of systems or their **components** and their probable **breakdown** time, P. WINIWARTER and C. CEMPEL have defined "life symptoms" and "life curves" in relation to **wear**. An "auto-regressive stochastic process" is observed. (1992, p.9-34).

1913

LIKEHOOD RATIO

→ **Bayes' Theorem**

1914

LIMIT^{1) - 2) - 4)}

The farthest **boundary** or **constraint** on some **process**, **subsystem** or system.

The limit is that which separates a system from its **environment**, or environmental conditions, in **space** and/or in **time**. A limitless system could not be a system at all. Limits may however be elusive in various ways: In **space**, a system has generally a **field** of influence whose **boundaries** are sometimes difficult to establish, and may be variable.

In **time**, **periodical** (or a-periodical) **variations** may expand or contract the limits of a system. The ignorance of this basic feature can be the cause of very serious problems. An example is the imprudent occupation or use of

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

the flood plains in river valleys. Another was the occupancy by uninformed British colonists of Kikuyu highland in Kenya from which Kikuyu people had to retreat after the rinder pest epidemics of the 1890's.

1915

LIMIT (Absolute) discrimination³⁾

The impossibility to differentiate sounds, colors, brightness and generally any **percept** under some minimum value.

According to K. KRIPPENDORFF, there is "...an **information** processing limit for absolute judgements by humans of about 3 **bits**" (1986, p.45).

Under this limit, confusion and errors increase rapidly. Discrimination limits are an important **constraint** in the construction of **models**.

It seems however that, through adequate **training**, discrimination limits can be somewhat extended. Examples are the use of 1/9th of tones in Indian music, or the enhanced color shades discrimination capacity of trained painters.

→ **Perception (Physiological limits to)**

1916

LIMIT CYCLE (Stable) (= Attractor)²⁾

"Closed integral curve which represents a **periodic regime**" (M. DUBOIS et al, 1987, p.193).

This **representation**, introduced by H. POINCARÉ, was indeed the first example of a (non punctual) **attractor**.

In order to obtain it, POINCARÉ introduced the notion of transverse arc: it is an arc of curve, which is tangent to none of the points of an integral curve (meaning that it intersects many times with the latter). Considering the succession of the intersections of an integral curve with a transverse arc, he reduces the study of the curve in the plane to the study of the succession of points on a line. POINCARÉ next shows that *any integral curve which does not end into a singular point is a cycle or a spiral asymptotically winding around the cycle, which he thus calls a limit cycle.*" (J.L. CHABERT & A. DAHAN DALMEDICO, 1991, p.568).

The limit cycle corresponds to the VAN DER POL equation which "describes the **behavior** of an **oscillator** which is kept going, with increase of the **oscillations** of reduced **amplitude** and decrease of those of wide **amplitude**." (P. BERGE et al, 1984, p.26).

Any **trajectory** of this kind converges towards the limit cycle, which corresponds to the type of systems tending to **oscillating dynamical stability**.

The basic condition for the existence of a limit cycle is a constant **input** of sufficient **energy** to the system. However, an excess of **energy** may throw it out of its **stability range**, in accordance with **thermodynamics of systems far-from-equilibrium**.

→ **See also: Cycle (Limit); Cycle (Stable limit)**

1917

LIMITING FACTOR¹⁾

An essential **component**, **flow** or condition whose absence, short supply or excessive concentration acts as a check on **growth** or even endangers the **survival** of a **population** or system.

According to A. LOTKA: "The significance of such limiting factors seems to have been first pointed out by J. LIEBIG: "The yield (of the soil) depends on the nutrient whose quantity is minimum".

LOTKA adds: "Limiting factors not only set certain bounds to the **growth** of the **components** to which they are thus related, but are competent also to give rise to the **phenomenon** of moving **equilibrium**" (1956, p. 97).

This is very important for **ecosystems**, which may "bounce" from one type of **equilibrium** to another under the influence of some positive or negative **variation** in a limiting factor.

G. WEINBERG proposed a "Law of limiting factors", as a generalization from the economist's Law of Diminishing Returns. (1975, p.45). However, the latter is merely a consequence of the first one, which seems more precisely causal.

In the same vein, J. WARFIELD enounced the following "Law of Limits": "To any **activity** in the universe there exists a corresponding **set** of limits upon that **activity**, which determines the feasible extend of the **activity**" (1991, pers.comm.).

WARFIELD states: "The limits may be active or inactive, generic or specific, fixed or movable, **autonomous** or responsive" (Ibid).

WARFIELD's law is very general. A frequent practical example of responsive limit is the logistic one, whose **logistic equation** is the mathematical formulation.

It would seem that any "**autonomous**" limit turns responsive when the encroaching system puts sufficient pressure on the **environment**.

1918

LIMITS TO PERCEPTION

→ **Perception (Limits to)**

1919

LINEAR²⁾

The property of any **process** or **function** whose increase or decrease follows a simple arithmetical **rate**, i.e. without any **positive** (i.e. accelerating) or **negative** (i.e. braking) **feedback**.

More simply, in a linear relationship "**variables** are increased or reduced by a constant quantity" (ROSEN, 1966, p.93).

Linear relations can be represented by a straight line in cartesian coordinates, which explains the use of this term.

→ **Linearity**

1920

LINEAR BEHAVIOR¹⁾

F. ROBB states: "...linear behavior is not the rule but just one special case of systems behavior in a predominantly **nonlinear** world. The linearities to which we have become so accustomed are the outcome of the use of our bounded rationality, and the tools which supported it, of our **language**, our mathematics, our simple logics and or self-imposed **constraints** such as OCKAM's Razor" (1990, p.137).

1921

LINEAR PROGRAMMING⁵⁾

"A combined analytical and **decision-making** technique based on mathematical programming" (I.G. BLOOR, 1988, p.24).

Linear programming uses algebraic and graphical **methods** in search of the optimal solution.

I.G. BLOOR explains that the aim is to find a suitable **equilibrium** between "**objectives** (e.g. maximize profits, minimize **waste**) and **constraints** (**resources** that are scarce, **time**)". He adds that: "The choice of **method** depends on the number of **variables** under consideration: more than two require algebraic (or computer) solutions".

He states that the technique is usable "... to provide feasible solutions to problems where the alternatives seem infinite or non-existent" (1988, p. 24).

Truly complex **situations** however frequently cannot be treated by linear programming.

1922

LINEARITY^{1) - 2)}

An arithmetical relation between quantities, i.e. characterized by a fixed arithmetic **rate** of increase or decrease.

$y = ax$, is a typical linear relation. Its **representation** is a straight line. It includes only **variables** of the *first order or degree*, affected by some arithmetic coefficient. It is merely **accumulative** at an invariable **rate** and corresponds to a permanent "one cause, one effect" **process**.

Linearity is a property of **processes** exempt of **positive** (accelerative), or **negative** (**dampening**) **feedbacks**. However, a positive or negative acceleration in itself can be linear, as derivation from a linear differential equation.

Truly linear **processes** are exceptional, even if during a limited **span of time**, a **nonlinear** one may look as linear. Trying to study **nonlinear processes** in linear terms is generally to no avail, as very few **processes** are immune to internal and/or external **constraints** expressed through **regulation loops** or **controls**. In such cases linear **models** may lead to gigantic (or subtle, which could be worse) **extrapolation** errors.

1923

LINEARIZATION ²⁾

The approximate **description** of a nonlinear **process** or system through a linear **model**.

Such a **reduction** is possible and useful only when the **behavior** of the modeled system is, for a **time**, only very slightly affected by **non-linear effects** and when there are good reasons to believe that this **situation** could not be suddenly reversed by a **change** in the basic conditions of existence of the system. Any appearing factor of acceleration or slowdown, **possible discontinuity**, or incipient **chaotic behavior** should be closely watched.

In particular, as expressed by R. MAY: "The elegant body of mathematical theory corresponding to linear systems (**FOURIER analysis**, orthogonal functions, etc.) and its successful application to numerous fundamental problems in physical sciences, tend still to dominate more or less advanced universities cursus in mathematics and physics. Mathematical **intuition** thus developed ill prepares the student to confront the strange **behavior** showed by the simplest **nonlinear discrete** systems, while however these **nonlinear** systems are surely the rule and not the exception outside the physical sciences" (1976).

1924

LINGUISTIC CLOSURE ²⁾³⁾⁵⁾

L. LÖFGREN emphasizes the closure character of our **languages** of all kinds, even mathematical or formal. He writes "The systemic **wholeness**, or the complementaristic nature, of the language implies a closure, or circumscription, of our linguistic abilities- be they "pure thoughts" communicable in a formal mathematical language, or constructive directions for an experimental interpretation- domain of a physics language. The nature of this closure is not that of a classical **boundary** of a capacity, like descriptibility, or interpretability. It is a tensioned and hereditary boundary of the systemic capacity of descriptibility- and- interpretability" (2000, p. 17-18)

He explains closure **tension** as the interactive **complementarity** between both capacities, where a better descriptibility somehow limits interpretability.

As to the closure as hereditary, he observes that "...at each **time** we try to communicate... we are confined to a shared language", i.e. the language that we received in its present state (as much as we did receive it) (p. 18)

An excellent example is this very Encyclopaedia: Interpretability can be obtained only by multiple **interconnections** between **description** terms. This is why so many cross-references are introduced.

As to the "hereditary" aspects, the users of the 2nd. edition inherit still a closed linguistic system, but whose **domain** has been much widened.

1925

LINGUISTIC DRIFT ^{1) - 3) - 4)}

The slow and progressive **changes** in **meanings** that affects words and concepts in any natural **language**.

This very significant systemic **transformation** remains mostly unperceived, because it is slow (it is the equivalent for **languages** of the "boiled frog parable").

It can only be observed after various decades, or at least years, and is more easily perceived by someone who returns to his/her own cultural system after a long absence. A similar **phenomenon** occurs in any expanding linguistic area: "Democracy" has not exactly the same **meaning** in Italy, England, United States, Kenya, or Australia. It may also produce misunderstandings, and even **conflicts** when new members in a culture or **organization** bring with them slightly different **meanings**.

J. WARFIELD stresses the importance of this **phenomenon** in **organizations**, where: "As the **organization** grows, linguistic separation grows both laterally and vertically in the **organization**". Particularly: "At higher vertical **levels**, **metaphors** and **categories** become progressively disconnected from the relevant **components** at lower **levels**, leading to **decisions** based on perceived **relations** between **categories** that are not borne out by **relations** between **category** members" (1995, p.129).

Linguistic drift even effect orthography, spelling and pronunciation. A growing number of errors and confusions can be observed nowadays in newspapers, magazines and even technical and scientific journals.

The main causes seem to be:

- interlinguistic contamination due to massive migrations and the wide diffusion of some **languages**, as for instance english as used by non-native english speakers

- the general abandonment (in western countries) of the study of classical greek and latin, as these languages tended to stabilize and standardize linguistic, and even interlinguistic uses

- the progressive **transition** from written and read transmission of **information** to verbal transmission in radio and television

Of course, linguistic drift always existed. This was the way for example how so-called latin languages (Italian, Spanish, Portuguese, Catalan, French, Rumanian) derived differently from latin until the latter became a "dead" language.

The main problem resulting from linguistic drift is **semantic** drift, which is in fact nothing else than the contemporary form of the "**Babel Tower**" effect.

In any way, this **process** is for now fully active in the whole world ...and encyclopedia's editors are in for a rough ride.

1926

LINGUISTIC HEDGE ²⁾

A **fuzzy** quantitative term used to relativize a primary term.

This concept has been introduced by L.A. ZADEH to allow for the **representation** of a degree of linguistic imprecision, according to his basic **concept of fuzziness**.

As examples of hedges he cites: "*very, much, slightly, more or less* (although *more or less* is comprised of three words, it is regarded as an atomic term), etc." (1973b, p.33).

1927

LINGUISTIC VARIABLES ²⁾

According to L.A. ZADEH: "... the ability to summarize **information** plays an essential role in the characterization of complex **phenomena**. In the case of humans, the ability to summarize **information** finds its most pronounced manifestation in the use of natural **languages**".

As a result: "If we regard the color of an **object** as a **variable**, then its values, red, blue, yellow, green, etc., may be interpreted as **labels** of **fuzzy subsets** of a universe of **objects**. In this sense, the attribute *color* is a **fuzzy variable**, that is, a **variable** whose values are **labels of fuzzys sets**", and

"... the main **function** of linguistic variables is to provide a systematic means for an approximate characterization of complex or ill-defined **phenomena**" (1973b, p.29).

Thus, "blue", as a fuzzy linguistic variable, includes light blue, sky blue, Prussian blue, ultramarine, etc... However, with "blue-green", a border **distinction**, we have already a problem.

1928

LINK ¹⁾²⁾

A connection between two **elements**.

Links are probably the most basic features of all kinds of systems from physics to sociology.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Graph theory describes numerous types of links and their more interesting **interconnections**, in **linkages** and gives a good understanding of **networks**

Links are **structural**, but correspond also to **dynamical** features in networks and/or systems. In graphs, this is made clear by giving them an orientation represented by an arrow-head. Structural and dynamical aspects are of course complementary.

→ **Cycle, Feedback, Hierarchy, Node, Process, Small worlds, Structures (organizational)**

1929

LINKAGE²⁾

A characteristic introduced among **elements** pertaining in common to different **parts** of a system.

A. BOGDANOV introduced this concept as early as 1922. He explains: "The linkage of two links in a chain is that part of one link which lay inside of the other; and especially the surface of their contact" (1980, p.69).

He adds: "Linkage denotes the 'entry' of **elements** of one complex into another, and vice versa" (Ibid).

"Complex", in BOGDANOV's terminology may be considered as meaning approximately "**sub-system**".

A linkage implies necessarily a **relationship**, which may appear only **structural**, but is generally a **dynamic** and **functional** one.

1930

LINKAGE PROPOSITIONS³⁾

"A way to connect any two or more **isomorphies** by describing their specific **cross-impact** on each other in a **semantic** sentence" (L. TRONCALE).

Linkages propositions have been introduced by L.R. TRONCALE in 1978 (see 1985, p.43-83), as a **methodology** to produce a better **organization** within the global **set** of systemic concepts and **models**. TRONCALE selected 75 principal concepts (most of them in this encyclopedia) as the basic **set** for the combinatory construction of linkages.

According to TRONCALE, a basic systemic **concept** must be endowed with the following characteristics:

- be at a sufficient **level of abstraction**
- not be anthropomorphic
- offer a phenomenological basis (i.e. be related to **concrete systems**)
- be ana-synthetic (i.e. at least potentially general)
- not be based on **methodology**
- be oriented toward some **process**
- be of use for the reciprocal definition of other basic systemic **concepts**
- allow for extensive **interactions** with other basic systemic **concepts**

- be really **transdisciplinary**
- be useful to clarify systemic **complexity**
- be a prime generator of systemic characteristics.

According to TRONCALE the following types of **concepts** should be avoided:

- terms with (according to him) anthropomorphic undertones as for example **axiology**, **epistemology**, systemic **causality** or systemic **behavior**;
- descriptive or classificative terms as **artificial intelligence**, **dynamic complexity**, systemic **evolution** or **isomorphy**;
- methodological terms as **modelization**, **simulation** or **mapping**.

As no linkage proposition can be totally isolated from **context**, their **validation** by controlled experiments as practiced in hard sciences is impossible.

TRONCALE proposes the following types of linkages:

- **congruent**, i.e. proposing an **isomorphy**, an **analogy**, **homology** or **identity**;
- **linear**, i.e. showing a causal, functional or necessary **interrelation**;
- **reciprocal**, showing a negation, **inhibition**, opposition, increase or decrease;
- **complementary**, marking a **symmetrical** or **complementary relation**.

Using his **methodology** TRONCALE constructs a **matrix** of potential linkages among the **set** of concepts, producing tentative propositions. Each of these must be verified in the major possible number of disciplines. All are of a quite general character as for example: "**Synergy** may result of a consonance of **cycles**". What is hoped for is an interlinked system of systemic concepts: Only the **set** of its linkages properly clarifies the sense of any concept.

TRONCALE enumerates moreover other possible uses of this **methodology**:

- enrich the **meaning** and **understanding** of each basic systemic concept;
- enrich the **understanding** of the origins of the specific **phenomenon** corresponding to each concept;
- enhance the **consciousness** of the dynamic character of systemic **processes**;
- help searching for more **isomorphies**;
- propose better tests of the basic systemic concepts and their linkages;
- enhance the predictive power of general systemic **models**;
- delimit and describe the areas that may require more attention and research;
- provide a **reference frame** to assess the value and the more or less embracing character of proposed **models** and **simulations** for the researched systems.
- offer a precise and efficient tool for teaching **General Systems Theory**.

The general organization of the present work widely takes in account TRONCALE's linkages **methodology** by explaining the **meanings** of terms and concepts through definitions and comments using other related terms and concepts. In this way, an interconnected **net** of **meanings** creates a coherent **semantic space**. However, emphasis is also extended wider afar, in order to connect concepts with **models** and specific disciplines, when needed even when this entails reference to so-called anthropomorphic terms (for ex. **image**, **norm**) or non-systemic abstract ones (for ex. **epistemology**).

1931

LINKS (Weak or strong)¹⁾²⁾

Strong links in systems are quite rigid, as they are difficult to break.

On the contrary, weak links can be easily loosened, but also easily constructed. This is a significant condition for **adaptability** in **complex systems**, from molecules to **brains** and, probably all types of **social systems**. For examples in chemistry, see J. THOMAS (1998)

1932

LINKTHINK^{2) - 4)}

The coordinated and productive mental **activity** in a **group** which has carefully explored the whole field of ideas related to the **issue**, **situation** or **problem** under scrutiny.

J. WARFIELD, who introduced this neologism writes: "With linkthink, members are asked to determine how those ideas that received at least one vote during the **Nominal Group Technique process** are related... This **activity** is carried out using a **methodology** called **Interpretive Structural Modelling**" (J.N. WARFIELD and C. TEIGEN, 1995, p.32).

This **process** of establishing **linkages** can be computer assisted. It normally produces "a graphical **structure** showing how **problems** are interrelated through the **relationship** "aggravates" (Ibid).

In this way a "**Problematique**" is constructed, which represents a global, integrated view of the **issue** considered.

1933

LITHOSPHERE¹⁾²⁾

The solid crust which envelopes the high temperature earth core.

In his ecological **model** of the **man-planet system**, Ch. FRANÇOIS uses the term "geosphere". Clearly the lithosphere includes also the submerged parts of the crust.

→ **Atmosphere; Biosphere; Ekistics; Hydrosphere; Sociosphere; World engine**

1934

LIVING SYSTEMS^{1) - 2) - 4)}

A general theory of living systems has been established by J.G. MILLER, who introduces it in global terms as follows: The general living systems theory... is a conceptual system concerned primarily with **concrete systems** which exist in **space-time**. Complex **structures** which carry out living **processes** I believe can be identified at seven **hierarchical levels**... **cell, organ, organism, group, organization, society**, and supranational systems. My central thesis is that systems at all these **levels** are **open systems** composed of **subsystems** which process **inputs, throughputs** and **outputs** of various forms of **matter, energy** and **information**". (1978, p.1).

At the time, MILLER thus identified **7 levels** and **19 critical subsystems**. More recently J. and J.G. MILLER completed this **taxonomy** by interposing the "**community**", as a supplementary **level** in-between the **organization** and the **society levels** and, on the other hand, one more **subsystem**, the "**timer**", which introduces a general **dynamics** which seemed to be lacking in the first presentation of the theory. (1992)

MILLER pursued in 1978: "I identify **19 critical subsystems**... whose **processes** are essential for life, some of which process **matter** or **energy**, some of which process **information**, and some of which process all three" (1978, p.1)

According to MILLER in his more recent statement, any system at any of the **8 levels** need the same **20 critical subsystems** but: "The **structure** and **processes** of a given **subsystem** are more complex at a more advanced **level** than at the less advanced ones. This is explained by what I call the evolutionary principle of "shred out", a sort of division of labor (as the)... general direction of **evolution** is toward greater **complexity**" (p.1).

For each **subsystem**, MILLER identifies "about a dozen **variables** representing different aspects of its **processes**. It would be easy to identify more if one wanted an exhaustive list. Each of these **variables** can be measured at each of the **levels**, and the sorts of variations discovered can be compared across the **levels**" (p.4).

This feature leads MILLER to his **cross-level hypothesis method** aimed at discovering **isomorphies** between **processes** and/or **structures** at different **levels**.

MILLER also states that "Physiology, biochemistry, genetics, pharmacology, medicine, economics, political science, anthropology, sociology and psychology are all almost entirely relevant. Physical science and engineering also contribute. Logic, mathematics and statistics

yield **methods, models** and **simulations**, including some involving the relatively new approaches of **cybernetics** and **information theory**" (p.4).

Consequently, MILLER's is a strongly integrated and all-embracing systems theory.

From a different viewpoint H. MATURANA states: "A living system is an inductive system and functions always in a predictive manner: what happened once will occur again. Its **organization** (genetic and otherwise) is conservative and repeats only that which works" (1970, as quoted in E.von GLASERSFELD, 1976, p.117).

In other words, it is said that biological systems become **organizationally closed** and thus **autopoietic**.

Still from another angle, A.S. IBERALL states: "... a living organism is a working **thermodynamic engine** during its entire life phase" (1973, p.4).

It is also a part of LOTKA's **world engine**.

It should however be noted that the living system is submitted, as shown principally by I. PRIGOGINE, to **specific thermodynamic laws** which allow it to organize itself in apparent contradiction with the 2d.law and to maintain itself as an island of **organization** during its whole life. The price is, however, an acceleration of the increase of **entropy** in the **environment**.

This is still more so for **self-organizing human groups** and **societies**, composed of living systems.

LIVING SYSTEMS: The 8 levels of complexity^{*}

J.G. MILLER defines a **hierarchy** of 8 basic types of living systems in order of growing **complexity**. Every **level** is made of **elements** of the immediately inferior **levels of complexity**. However, all of these are ordered in **20 critical subsystems**, i.e. they are not merely unordered **congeries**.

The first three **levels** are biological: The **cell**, the **organ** and the **organism**.

The fourth, i.e. the **group**, is an ordered reunion of **organisms**, and intermediate between the biological and the (human) social **level**. MILLER did not consider the case of social insects or plant **colonies**.

The last four **levels** are social: The **organization** (e.g. an enterprise), the **community** (e.g. a town, or city), the **society** (a state) and the **supranational system**. (the numerous and more or less connected international agencies: U.N., UNESCO, UNEP, WHO, FAO, etc. (1993, p.158).

In his first versions of "Living systems" (1965, 1978), MILLER described only seven **levels**. The new **level** he introduced is the "**community**", mediatory between the **organization** and the **society**. His **model** for the supranational system was the European Community, as it was in 1978.

One wonders if the eighth level should not be the man-planet system, whose **subsystems** would be the various international **organizations** formerly mentioned, and others instances still to be created. Could the Internet not become for ex. the communication subsystem of the planetary system?

LIVING SYSTEMS: The 20 critical subsystems

See the complete listing under: "**Subsystems**" and each specific type of **subsystem** under the corresponding alphabetic listing.

1935

LOCALITY^{1) - 3)}

The hypothesis according to which no **element** or system can exercise an unlimited **action** at distance, and still less so, an instantaneous one.

Or "The **dominance** in a limited **region of space** of specific conditions of **interactions** among **elements**".

It is finally amazing to note how many shades of **meaning** such an apparently clear **concept** can evoke.

D. TSAGDIS, for instance, writes (in a footnote!): "Locality is semantically over-loaded. It can refer, for example, to: a Cartesian spatio-temporal **space**, a Husserlean **experiential region**, a Heideggerian horizon, a Wittgensteinian **language game**, and/or their syntheses. A more helpful way of understanding such a rich notion is to conceptualize it as constituted by the four sources of observational **error**, viz. **observer, context, object, language**.

This would be a "richer" or, dare I say, more complex locality constituted with all four sources of error..." (2002, p. 152)

In other words, **fields** are not infinite and, in accordance with relativity, the light's propagation velocity cannot be surpassed.

This hypothesis seems now to compete with D. BOHM concept of **non-locality**. This could lead to a deep reevaluation of many scientific concepts.

→ **Energy; Matter; Perceptual field; Space; Time**

1936

LOCALIZATION²⁾

W.R. ASHBY explains how, in the nervous system, **perceptive dispersion** allows for a measure of localisation in cerebral activity, which insures the **heterogeneity** needed within any **complex system** (1960, p.178-80).

He however quotes LASHLEY, who remarked "...that the **memory-traces** might be localised individually without conflicting with the main facts, provided there were many traces and that they were scattered widely over the cerebral cortex, unified functionally but not anatomically" (Ibid., p.183).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Such a kind of "untidy" localisation in the cerebral **network** is neither rigorously **deterministic**, nor totally **random** and combines the advantages of ordered **organization** with those of scattering which offers possibilities of numerous new recombinations.

1937

LOCATION¹⁾

A precise site in a **space-time** slice that is sufficient to individualize some **entity** at a given moment.

Locations in **space** are necessarily correlated to moments in **time**.

1938

LOCATIONAL DECOMPOSITION^{2) - 3)}

"The conceptual separation of **parts** of a system according to their relative **locations** within a continuum of **space** and/or **time**" (N. TODA & E. SHUFORD, 1965, p.26).

The authors obviously introduce the word "conceptual", as any decomposition is – more or less – a result of the **understanding** of the **observer**.

1939

LOCK-IN EFFECT^{1) - 2) - 3)}

A condition in which some previously acquired characteristic in a system blocks further **changes**.

Existing **situations** tend to create "**frozen cores**" within systems. This is frequent in technical devices, as observed for instance by S. J. GOULD, who describes the way the old QWERTY keyboard blocks since many years the introduction of better keyboard designs (1991). It also may be the cause that slows or blocks for long time new scientific **paradigms**. For instance, one may think that the global view proposed by **systemics** is thus blocked by the dominant specialized approach.

The anonymous peer review system is instrumental in producing lock-in effects against scientific innovations, according to A. BEREZIN et al. (1995).

1940

LOCK-IN EFFECT¹⁾²⁾

The way a system becomes more or less **irreversibly** dependent on its former **adaptations**

This is a universal effect, from oxygen dependence for breathing of superior animals (which is absolute) to the strong dependence of modern transportation on non-renewable fossil fuels as their source of **energy**.

The lock-in effect may easily become dangerously critical and its possibility should be carefully evaluated when some new adaptation is considered.

This is why the principle that "**fit** is not forever" is important and also why **adaptability** is to be always maintained as much as possible.

→ **Caution principle**

1941

LOGARITHMS: Their use in information theory⁵⁾

Dual logarithms (i.e. to base 2) are a measure of the number of **binary decisions** (**BITS** = binary digits) needed to suppress **uncertainty** in a **situation**.

Log₂N also measures ASHBY's **variety**, as indicating the number of successive **choices** to be made in order to obtain a precise **distinction**. ASHBY gives the following example: "What is the **variety** in **bits** of the 26 letters of the alphabet?" The reply is 4,7 **bits**, i.e. in practice 5 successive **choices** to be made to completely determine the position of one specified letter within the English alphabet, using yes or no answers to questions like: Is it in the first half of the alphabet? Is it in the 2nd half of the first half?, etc.

1942

LOGIC : A Critical View³⁾

G. BATESON states that "Logic is a poor **model** of **cause and effect**" (1979, p. 58)

He observes that we are mistaken when "we use the same words to talk about logical sequences and about sequences of cause and effect" (Ibid)

In fact, the difference is that the cause-effect sequence exist in the **time dimension**, while the logical one is a timeless abstraction. Or, in other words, the cause-effect sequence is considering **events**, and thus energetic **transformation**, while the logical sequence is merely a quite limited- and in a sense, static- model of **linear causality**. In particular, it ignores closed loops brought about by **feedbacks**.

This is noteworthy, since we had to wait until the 20th C. to discover that the fabled implicit contradiction in the famous sentence: "Epimedes the Cretan says that all Cretans are liars", contains in fact a feedback which is the cause of the irreducible **ambiguity**.

→ **Types (theory of logical)**

1943

LOGIC AND CULTURE³⁾⁴⁾

M. MARUYAMA states that different cultures tend to adhere to different types of reasoning (1994, p. 2-4)

As an example: "the logic that is taught in European and North American schools is called "Aristotelian logic", or "Cartesian logic", named after Aristotle (384-322BC), the Greek philosopher, and Descartes (1596-1650), a French philosopher. It is also called "Von Neumann logic" by computer people. It is based on classificational and hierarchical thinking, and it

denies the possibility that many things can cause one another". This is of course the root of rigorous **linear causal determinism**, which still dominates most of western thought.

However other views exist in other **cultures** and even within western cultures some individuals share them. **Cybernetics** for ex., by introducing **feedbacks** (**positive** or **negative**) is bending **deterministic causality** onto itself, so to say.

More recently determinism has turned "**chaotic**", when it became clearer that any **event** is in fact the complex result of a twisted and complex **set** of causes concurring to shape some present **event**.

Maruyama writes that the cybernetic view, and other ones have existed and still exist implicitly in various non-western cultures and that in every **culture**, "in any society at any time there is **heterogeneity** of logics among individuals" (Ibid). However one specific type of logic normally becomes dominant in a culture.

Nevertheless, the existence of individuals of other types in the culture always opens the way for possible switches.

→ **Mindscales**

1944

LOGIC AS A METAPATTERN³⁾

T. VAMOS et al, who consider that **patterns** that we perceive or define (constellations of stars for example) are basically **metaphors**, resulting even in some cases from the phylogenetic **evolution**.

They go still further and write: "Logic as a high development of this **evolution** is a meta-pattern itself, a **pattern** of some regular **pattern** relations" (1992, p.1609).

This is an interesting idea, if one considers the extensions of logic during the 20th century under the impact of some perceived contradictions and imperfections within the limits of traditional logic.

1945

LOGIC (Structure of)¹⁾³⁾

According to K.L.von BERTALANFFY: "It may be that the structure of our logic is essentially determined by the structure of our central **nervous system**. The latter is essentially a **digital computer**, since the **neurons** work according to the **all-or-nothing** law of physiology in terms of yes-or-no **decisions**. To this corresponds the Heraclitean principle of our thinking in opposites, our bivalent yes-or-no logic, **Boolean algebra** and the **binary** system of numbers to which also the practically more convenient decadic system can be reduced (and is actually reduced in modern calculating machines)" (1962b, p.245)

Thus our way to perceive and make **models** of the outside world seem to be closely dependent of our physiology.

1946

LOGICAL DEPTH⁵⁾

"The amount of **time** it would take a computer to generate a **simulation** of a system".

This definition is due to Ch. BENNETT, as quoted by J. HALLIWELL (1995).

This is of course a **binary** logic feature.

1947

LOGICAL OPERATIONS (Basic)^{3) - 5)}

"And" and "or" are the basic **operations** of logic. Together with "no" (the logical **operation** of negation) they are a complete **set** of basic logical **operations** - all other logical **operations**, no matter how complex, can be obtained by suitable combinations of these" (J.von NEUMANN, 1958, p.53).

These logical **operations** correspond to **binary logic** and are directly derived from G. BOOLE's "Laws of thought" (1854, reprinted 1952). They can be easily represented by **VENN diagrams**, now **fractalized** by A. EDWARDS (1989).

1948

LOGICAL TYPES (THEORY of)³⁾

The theory of logical types was established by B. RUSSELL and A.N. WHITEHEAD in their "PRINCIPIA MATHEMATICA".

G. BATESON synthesized it as follows: "... the theory asserts that no **class** can, in formal logic or mathematical discourse, be a member of itself; that a **class** of **classes** cannot be one of the **classes** which are its members; that a name is not the thing named..." (1973, p.250).

As expressed by G. BATESON (1979, p.229): "A series of examples is in order:

1. The name is not the thing named but is of different **logical type**, higher than that of the thing named.

2. The **class** is of a different **logical type**, higher than that of its members.

3. The injunction issued by, or **control** emanating from, the bias of the house thermostat is of higher **logical type** than the control issued by the thermometer. (The bias is the device on the wall that can be set to determine the temperature around which the temperature of the house will vary).

4. The word "tumbleweed" is of the same **logical type** as "bush" or "tree". It is not the name of a species or genus of plants; rather, it is the name of a **class** of plants, whose members share a particular style of **growth** and dissemination.

5. Acceleration is of a higher **logical type** than velocity"

The theory of logical types was established in order to eliminate logical paradoxes whose best known example is the assertion by EPIMENIDES *the Cretan* that all Cretans are liars, a self-contradictory statement.

In R.von MISES words: "It constitutes the first step toward a general rational conceptual **structure** and discards old pseudo problems".

It has an obvious relation to **GÖDEL's incompleteness theorem**, and far from having only abstract bearings, it is very useful to clear logico-semantic muddles and many innocently or artfully distorted pseudo-logical arguments, for example in psychology.(1973, p.250 - 279).

It is a necessary tool for the establishment of **hierarchies of isomorphisms in General Systems Research**.

1949

LOGICO-MATHEMATICAL LANGUAGE (Meaning in a)³⁾

Logico-mathematical languages are unambiguous.

H. ATLAN writes: "There is a one to one correspondence between the **symbol** and its meaning but at the same time, as a formal language, it can exist as a **structure** of **symbols** without them having any **meaning**; in other words, whenever the language reaches the state of having non **ambiguous** meanings, it can be formalized and exist without any **meaning**." (1972, p.246).

Of course, this should be understood as "without any specific or concrete **meaning**."

1950

LOGISTIC EQUATION^{2) - 5)}

The logistic equation was introduced in 1838 by the Belgian demographer L. VERHULST. It is generally written in two different forms:

$$(1) X_{n+1} = aX_n (1 - X_n) \text{ or} \\ (2) X_{n+1} = aX_n - aX_n^2$$

The aX_n^2 member expresses the progressive braking effect on **growth** due to some inherent **constraint**, activated by the systems or **process growth** itself. Generally speaking, this **constraint** is the rarefaction of the basic **resource** that feeds the system or **process**, due to its growing consumption.

As observed by C. MARCHETTI, quoted by J. CASTI, this logistic growth is characteristic of the **evolution** of any type of **populations**, even in "psychological, social, technological and political **phenomena**" as for example MOZART's musical works, construction of Gothic cathedrals in Europe and the volume of world airline traffic" (1994, p.37).

The braking factor can be nutrients, available **space**, overextension of **communication** lines or some **limit** of the brain's **network combinatorics** capacity.

1951

LOGISTIC EQUATION AND CHAOS^{2) - 5)}

Curiously, the logistic equation has been studied during more than one century and put to considerable uses, before anybody noted its

strange properties for higher values of the coefficient a . (See for example A.J. LOTKA, 1956, and V. VOLTERRA's, 1931 works).

However, some aspects of **populations** dynamics remained unexplained by the equation and this fact was more than once attributed to some insufficient **data** or statistical errors.

More recently, it has been discovered that, as stated by R.V. JENSEN: "The **time-evolution** of x_n , generated by this single algebraic equation exhibits an extraordinary **transformation** from **order** to **chaos** as the **parameter** a , which measures the **strength** of the **nonlinearity**, is increased... In fact, the review article on the logistic map by the biologist Robert MAY (1976) is a historical milestone in the modern development of **nonlinear** dynamics" (1987, p.170).

This **chaotic randomness** of the logistic equation, once a specific **threshold** is crossed, is explained by J. CASTI as follows: "When we put the birth and **overcrowding effects** together into a single expression, what pops out is the formula for **randomness**" (1990, p.94).

Moreover, as **overcrowding** results of an excess in **inputs**, this feature of systems becomes related to PRIGOGINE's **thermodynamics of systems far-from-equilibrium**, submitted to giant **fluctuations**.

Grounding his analysis on the quadratic form (2) of the logistic equation, JENSEN writes: "When the original **population** X_0 is small (much less than 1 on a normalized scale, where 1 might stand for any number, such a 1 million individuals), the **nonlinear** term can initially be neglected. Then the **population** at time-step (year) $n = 1$ will be approximately equal to aX_0 . If $a > 1$, the **population** increases. If $a < 1$, the **population** decreases. Therefore, the **linear** term in equation (1) can be interpreted as a **linear growth** or death **rate** which by itself would lead to **exponential population growth** or decay. If $a > 1$, the **population** will eventually grow to a value large enough for the **nonlinear** term $-aX_n^2$ to become important. Since this term is negative, it represents a **nonlinear death rate** which dominates when the **population** becomes too large" (1987, p.170).

So far, so good.

However, while the "...graphic analysis tells us that if the normalized **population** starts out larger than 1, then it immediately goes negative, becoming extinct in one time-step" (Ibid.); for values of a between 0 and 4, "Conventional **perturbation** theory gives no hint of the existence of a nonvanishing **steady state population**" (p.171).

"For values of a between 1 and 3 almost all initial **populations** evolve to this **equilibrium population**" (See **asymptotic stability**). "Then, as a is increased between 3 and 4, the **dynamics** change in remarkable ways. First, the fixed point becomes unstable and the **population** evolves to a **dynamic steady state** in

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

which it alternates between a large and a small **population**... (a **period-2 cycle**). For somewhat larger values of a this **period-2 cycle** becomes unstable and is replaced by a **period-4 cycle** in which the **population** alternates high-low, returning to its original value every four time-steps. As a is increased, the **long-time** motion converges to **period** -8, -16, -32, -64 **cycles**, finally accumulating to a **cycle** of infinite **period** for $a = a_{\infty} 3,57$ " (Ibid.) In other words, at this value, **chaotic stability** is achieved and for higher values of a the **evolution** of **populations** "... is indistinguishable from a **random process**, even though the logistic map is fully deterministic in the sense that there are no "random" forces and that the future is completely determined by the **initial condition**, X_0 .(p.171).

This is an absolutely general property of the logistic equation, for any kind of **populations** and is thus a general systemic property.

1952

LOGON ³⁾ - 4)

"The unit of **structural information** is that which enables one such new distinguishable group to be defined for a **representation**." (D. GABOR, as quoted by D.G. Mac KAY)

Mac KAY, who adapted GABOR's concept, comments:

"Thus **structural information** is not concerned with the *number* of **elements** in a **pattern**, but with the possibility of distinguishing between them" (1969, p.165).

This is the same characteristic difference which exist between **homogeneity** and **heterogeneity**, in **space** as well as in **time** as the following example given by MacKAY expresses:

"...if we are counting identical sheeps jumping through a gate, and we have no sense of **time**, our result can only be represented by a certain total number; but if we have a clock we can now define what we mean by "the number in the first minute" and "in the second" and so forth, and represent our result by a set of *distinguishable* subtotals. The clock has provided **structural information**. In a similar way the ability to distinguish (e.g) spatial position along the gate would provide distinguishable subtotals and hence increase the **structural information-content** of our **representation**" (p.165).

1953

LOGON CONTENT ³⁾ - 4)

"The **structural information content** or number of logons (number of independently variable features) in a **representation**" (D. Mac KAY, 1969, p.165).

As an example, Mac KAY gives "the number of independent coefficients required to specify a given waveform over a given **period of time**" (Ibid).

One should possibly further extend the concept of logon. G.R. JOHNSON observes that: "(The) **content** (of an **information**), whether contained in an act of speech or "processed" by a nervous system, can only be inferred from the linguistic and other **behaviors** of humans", and... "... deaths threats are not equivalent to marriage proposals, even if they contain the same number of **bits of information**" (1992, p.1148).

1954

LOOP ¹⁾ - 2)

A closed circular **interconnection** between two or more interacting systems or **subsystems**, allowing for the **emergence** of a **positive** or **negative feedback**.

Loops are necessary for any type of **regulation** or **control**. In the case of **positive feedback** loops, that creates **heterogeneity**, M. MARUYAMA observes: "There are qualitative aspects as well: a) the basic principle of social, biological and even some physical **processes** is increase of **heterogeneity** and **interaction** among **heterogeneous elements**; in these **processes**, **heterogeneity** is necessary and desirable; b) qualitative improvements occur, such as **evolution**, as a result of **heterogenization**; c) genuine new **patterns**, not new combinations of old **patterns**, arise from **interaction** among **heterogeneous elements**" (1994, p.79).

1955

LOOP CIRCUIT ¹⁾ - 2) - 4)

A systemic **control** device which recycles materials and rewards and stimulates **parts** in proportion to their effectiveness (adapted from H. ODUM, 1971, p.150).

ODUM states: "Either too much or too little **growth** by one **component** puts the loop out of harmonious **flow**" (Ibid).

Any **complex system** - biological, ecological, economic or political - must be and remain **balanced**.

Unfortunately, in some cases they are not and man aggravates many systemic problems by unwittingly creating not sustainable disbalances, i.e. breaking loop circuits.

1956

LOOP (Self-replicating)→ **Self-replicating loop**

1957

LOOP (Self-reproducing) ²⁾⁵⁾

The self-reproducing loop - discovered by C. LANGTON - is, to date, the simplest **cellular automaton** able to reproduce its own **form** and propagate in an **isotropic space**.

For a short description, see C. EMMECHE (1994, p.59), after C. LANGTON original paper (1984, p.135-44).

→ **Garden of Eden**

1958

LOOP (Sensory-motor)→ **Sensory-motor loop**

1959

LOOP STABILITY ²⁾

J. MILSUM states: "... the particular dynamics and **parameter values** of the loop... are critically important in determining its **stability**" (1968, p.46).

Either **positive** or **negative feedbacks** may, in the long run, destabilize a loop and, finally, destroy it. A reiterative and not compensated **positive feedback** leads to a destructive **run-away event**: an out of order thermostat may induce a fire, which will destroy the **regulation** loop.

A not compensated **negative feedback** finally annulates any **regulation** and drives the loop out of existence: once past a certain point of **decay**, the renewal **cycle** of a **population** may disappear (and the **population** together with it).

1960

LOOPS (Causal) DIAGRAM ¹⁾ - 2)

A **graph** representing the **interconnections** between causes and **effects** within a **complex system**.

Complex **nets** of loops can be represented by **oriented graphs**.

Such **graphs**, proposed by M. MARUYAMA include through a convenient notation system, the directions of influence, **amplitudes** and **time delays**.

MARUYAMA justify the necessity as follows: "Use of sophisticated computer **simulation programs** remove **strategy decision makers** from direct comprehension of **interrelations** among key **variables**, because it suffices for the **program** user to look at the **input** and the **output** without knowing what takes place in the **program**" (1992, p.37).

In such a **situation** the **decision maker** may easily ignore if the **program** really represent what is going on in the **concrete system**... and even in some cases, does not possess himself a clear **understanding** of the same.

MARUYAMA, by introducing **time delays**, gives a dynamic character to his diagrams. Moreover: "**Adjustment of time delay** in one **element** to increase or decrease change **amplification** of a loop is an example of **action** suggested in the preliminary causal loop diagram analysis" (p.38).

In short, these diagrams are very useful thinking devices for managers and generally for all participants in the **organization**.

1961

LORENZ's BUTTERFLY²⁾ – 5)

"The mere flapping of a butterfly's wings could spawn hurricanes after not too long a time and very far away". This image was proposed in the 1960's by E. N. LORENZ, a meteorologist at the M.I.T.

While not utterly impossible, this should of course be taken as a portentous **metaphor** about **chaotic behavior** and high **unpredictability of complex systems**, due to their **high sensibility to initial conditions**.

1962

LUSSER Theorem²⁾

The **probability of resistance** (or **reliability**) of a chain of **components** is the product of the probability of resistance or reliability of all of its **elements**.

This implies that no composite system can be more resistant or reliable than its weakest element.

This property is determinant in the analysis of **failures** in a system.

→ **Failure tree**

1963

LIAPOUNOV EXPONENT²⁾ – 5)

The exponent $1/\tau$ of the function $e^{1/\tau}$ established by LIAPOUNOV.

LIAPOUNOV's exponents express the rate of **separation** or **convergence** of a **dynamic system's trajectories**. "And if either of these numbers is positive, indicating a positive rate of **separation** of the initial points in a given direction, we say that the system is **chaotic**" (J. CASTI, 1990, p.100).

"A negative exponent means **limit cycles** and at least a somewhat regular **behavior**. A positive exponent means **chaos**" (C. ZIMMER, 2000, p.84).

J. GLEICK explains: "The Lyapunov exponents in a system provide a way of measuring the conflicting effects of stretching, contracting and folding in the **phase space** of an **attractor**. They give a picture of all the properties of a system that lead to **stability** or **instability**. An exponent greater than zero means stretching – nearby points would separate. An exponent smaller than zero means contraction... For a fixed-point **attractor**, all the Lyapunov exponents are negative, since the direction of pull is inward toward the final **steady state**. An **attractor** in the form of a **periodic orbit** has one exponent of exactly zero and other exponents... negative. A **strange attractor**... has... at least one positive Lyapunov exponent" (1987, p.252).

In I. PRIGOGINE and I. STENGERS words: "A **behavior** is **chaotic** if **trajectories** starting from points as close as wanted in the **phase space**, move away from each other in **time** in an exponential way. The distance between any

two points belonging to such **trajectories** grows thus in proportion to a function $e^{1/\tau}$, in which $1/\tau$, positive by definition for **chaotic systems** is Lyapunov's exponent and τ Lyapunov's time... After an **evolution time** long in relation to Lyapunov's time, the **knowledge** that we possessed from the **initial state** of the system has lost its **relevance** and does not permit us anymore to determine its **trajectory**" (1992, p.77).

Thus, when τ is positive, it defines **irreversibility in time**, in conformity with the **2nd. Law of thermodynamics**.

M

1964

MACHINA SPECULATRIX²⁾ – 5)

The British neurologist W. Grey WALTER experimented during the fifties with a device which he described as follows: "The machine... is a small creature with a smooth shell and a protruding neck carrying a single eye which scans the surroundings for light **stimuli**. Because of its general appearance we call the genus "Testudo" or tortoise...

"(The device) contains but two functional **elements**: two miniature radio tubes, two sense **organs**, one for light and the other for touch, and two **effectors** or **motors**, one for crawling and the other for steering" (1955, p.126).

The set received its **energy** from two small batteries. WALTER added: "The number of **components** in the device was deliberately restricted to two in order to discover what degree of **complexity of behavior** and **independence** (Note: we should say "autonomy") could be achieved with the smallest number of **elements** connected in a system providing the greatest number of possible **interconnections**.

"From the theoretical standpoint two **elements** equivalent to **circuits** in the nervous system can exist in six **modes**; if one is called A and the other B, we can distinguish A, B, A+B, A>B, B>A, and A.B as possible dynamic **forms**. To indicate the **variety of behavior** possible for even so simple a system as this, one need only to mention that six **elements** would be more than enough to form a system which would provide a new **pattern** every tenth of a second for 280 years – four times the human lifetime of 70 years" (p.126-7).

Machina speculatrix displayed indeed a very complex **behavior** and still more so when two of them were in the **field**, falling even sometimes in a **double-bind behavior**, or appearing to have some degree of self-awareness. WALTER's research was apparently not carried along, but becomes now renewed in the guise

of new experiments on groups of more or less elemental **automata**, endowed with **directive correlations** (see for ex. J. ERCEAU, & J. FERBER, 1991).

1965

MACHINE¹⁾ – 2)

1. Anything "which behaves in a machine-like way, namely, that its internal **states**, and the **state** of its surroundings, defines uniquely the next **state** it will go to" (W.R. ASHBY, 1981, p.53).

2. "A set of material **elements** disposed in such a way to permit the execution of some definite **operation**" (L. COUFFIGNAL, 1951, p.17).

COUFFIGNAL distinguished:

"**Natural machines**: Machines composed of **organs** of living beings" (Ibid).

To talk about "Natural machines" seems inconvenient, since it tends to perpetuate the strong dominance of the mechanistic **model** of nature.

Even so, the **metaphor** is still very strongly sustained, as shown by the following (1984) text by J.L. DENEUBOURG et al: "The ants' nest seems to be like a machine which has no **breakdowns** and which is remarkably adaptable thanks to its **design**. A machine like this only needs to be partially programmed, since its **programme** organises itself".

Of course, "nobody" designed the ants' nest, nor wrote down a **program** for it. The authors concedes as much: "... when you observe an ants' nest, you can't help but think that it embodies another solution: that of **self-organization**".

They moreover observe: "In a world which lays more and more value on machine **autonomy**, subservient systems designed to process larger amounts of **information** evermore rapidly provide an initial answer". They conclude that both solutions "will perhaps be complementary in the post-industrial culture" (Ibid).

The still unsolved problem is how to find a way to let the various **subsystems** interact *simultaneously*, in real time, allowing for *some* more or less **deterministic chaotic behavior** without sinking into total incoherence, i.e. how to **organize emergent organization** at the global system level.

"**Artificial machines**: (according to COUFFIGNAL): "Machines constructed by man, for the **purpose** of replacing him in some **action**".

He adds: "We may agree that the lack of any qualificative means "artificial machines", i.e. machines in the older sense" (Ibid).

The artificial machine must be *constructed*, i.e. structured according to a project or **program** and its use depends in turn on a **functional program**. Apart from wear and tear, or

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

being *out of order*, which are limitative degradations of **structure** and **function**, it cannot produce any new and original **behavior** and has no **self-reproduction** capacity.

Further on, COUFFIGNAL writes:

"As we have seen, it is from the artificial machines towards the natural ones that, in most cases, a partial **similarity** will be extended, when found out. Let us remember, to use a precise terminology, that an artificial machine, constructed in view of applying the analogic **method**, is a mechanical **model**" (p.19).

As an historical example, COUFFIGNAL explains the artificial nerve, constructed by Ralph LILLIE in 1922, whose **behavior** led physiologists to admit that the transmission of nervous influx is a physico-chemical **phenomenon**. This conclusion has been widely confirmed by neurology before and after COUFFIGNAL's paper (1951).

However, as COUFFIGNAL still states: "...analogy must be applied mainly to **functional similarities**, and in a lesser fashion, to **similarities of organs** (p.21).

In any case, one wonders if, for many people, the **machine analogy** is really more than a frequently quite feeble **metaphor**, imprudently used.

To put some order and avoid dubious **isomorphies**, it is possible to establish a comparison between specific characteristic of so-called "natural" machines and artificial ones.

NATURAL	ARTIFICIAL
Can generally compensate partial failures	Stops functioning if some element breaks down
Cannot be reconstructed if taken apart	Can be reconstructed if taken apart
Can reproduce its own parts at least up to a point	Is not able to reproduce its own parts
Has autonomy , i.e. is able to compensate up to a point environmental variations.	Is totally dependent of its environment .
Can adapt and evolve by itself	Can merely be programmed, controlled and steered.

According to H. ATLAN "...a machine can be formally defined in the most general possible way by a **set E** of internal **states** and a set **I** of **inputs**. The machine's working is the way by which the **inputs** and internal **states** at a given moment **determine** the internal **states** at the next moment...

"We speak of **self-organization** in a strict sense, if the machine is able to change itself its **function F**, without any **environmental** interference, in such a way as to become ever better adapted to its own aim.

"Would this be possible, it would mean that **F** does modify itself" (as an **exclusive** consequence of the **set** of its internal **states**) (1972, p.25).

Such a conclusion could not easily be sustained. Indeed, in this case, the "machine" would be an **isolated system**, rigidly submitted

to the **Second Principle of thermodynamics**, and the progressive increase of produced **entropy**, not compensated, would lead it to total disorganization.

Besides, the machine as described by ATLAN, is strictly **deterministic**. Thus, it cannot be a satisfying **model** for **complex systems** and we should remain very careful with the "machine" **metaphor**, as used at least since the 17th. century.

1966

MACHINE (Determinate) ²⁾

"That which behaves in the same way as does a closed single-valued **transformation**" (W.R. ASHBY, 1958, p.24).

ASHBY explains: "The series of positions taken by the system *in time* clearly corresponds to the series of **elements** generated by the successive **powers** of the **transformation**. Such a sequence of **states** defines a **trajectory** or **line of behavior**... Next, the fact that a determinate machine, from one **state**, cannot proceed to *both* of two different **states** corresponds, in the **transformation**, to the restriction that each **transform** is single-valued" (p.25).

Determinate machines are **trivial** in von FOERSTER's sense, i.e. their **behavior** is perfectly predictable.

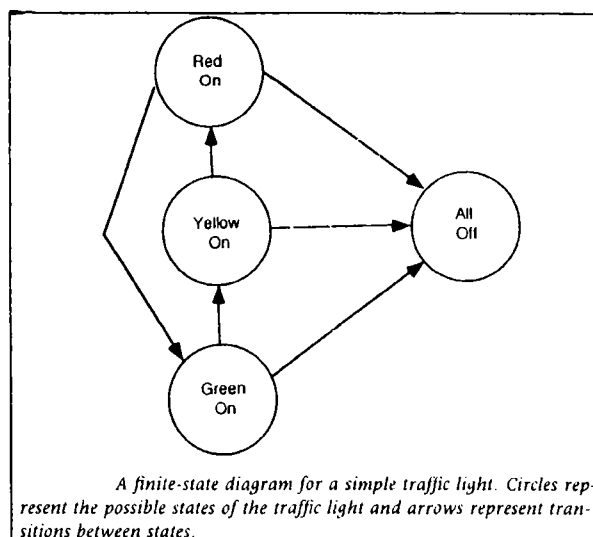
1967

MACHINE (Finite state) ¹⁾²⁾

"Any device that has a specific number - i.e. a finite number - of possible conditions" (M. CAUDILL, 1992, p.46).

M. CAUDILL writes: "The best everyday example of a finite **state** machine is a traffic light. A simple traffic light can be in any one of four possible **states**. There are no other possible

Figure: see entry **Machine (Finite states)**



states for that traffic light ... It never, for example, has all three lights on... Each of the three lights is either on or off, and each of the **states** is well defined and predictable. Furthermore well defined **transitions** exist between the **states**" (p. 46).

In this precise case, it should be added that the different **meanings** attached to the different **states** results of a significant **semantic code** that must be learned independently.

see figure below

1968

MACHINE METAPHOR (The) and its Mechanic ³⁾

In his book "Order and Life", J. NEEDHAM describes the ultimate **mechanicism** subjacent in DRIESCH's **vitalistic** biology. He writes "...it was DESCARTES who introduced the practice of calling **organisms machines**, and then postulating transcendent mechanics to drive them" (1958, p. 74)

Of course, in the western **culture** setting, a unique transcendent Mechanic is finally postulated. This is in deep harmony with monocausal **determinism** and the concept of a pyramidal (and generally autocratic) **model of hierarchy**.

One of the most subtle and deepest conceptual mutation of the 20th C. thought has been the recognition of multi-causal (and ultimately **chaotic**) **determinism** and **network causality**. It is not to say that simple determinism and hierarchical **organization** should be excluded. but they must obviously be inscribed within the more general views as specific and special cases.

The progressive evolution of biology from mechanicism, to **vitalism** and, further on, to the **organismic** view (as proposed by WOODGER and BERTALANFFY among others) testifies

from: CAUDILL, Maureen: "In our Image" - Oxford Univ. Press, New York, Oxford, 1992

to the progressive shift away from the machine metaphor to a more **holographic** one. Let us however beware of possible restrictive effects of an eventual abuse of a dogmatic pure **holistic** view, carrying along the ghost of the "mechanic"

1969

MACHINE (Non-trivial) ²⁾ - ³⁾

A machine whose **behavior** may change in a non-predictable way.

H.von FOERSTER states: "The great difference between **trivial** and non-trivial machines consists in that these latter depend of their internal conditions at different moments, which themselves have been influenced by former operations" (1992, p.62).

According to von FOERSTER, non-trivial machines are:

- globally **determined**
- analytically **undeterminable**
- depending on their past
- non-predictable

In most recent terms, they are **ergodic**, or downright **chaotic**.

von FOERSTER also writes: "(Non-trivial machines) **input-output relationship** is not **invariant**, but is determined by the machine's previous **output**. In other words, its previous steps determine its present **reactions**. While these machines are again **deterministic** systems, for all practical reasons they are unpredictable: an **output** once observed for a given **input** will most likely be not the same for the same **input** given later" (1981, p.201).

This description corresponds to evolving and in some measure to adapting systems and to **deterministic chaos**.

Applying the triviality concept to **living systems**, von FOERSTER states: "Instead of searching for **mechanisms** in the **environment** that turn **organisms** into trivial machines, we have to find the **mechanisms** within the **organisms** that enable them to turn their **environment** into a trivial machine" (1981, p.171).

There seems to be a kind of trade-off between organized systems and their **environment**. **Complexity** of the first tends to trivialize the second. This seems related to the **2d Principle of thermodynamics** and the increasing **entropy** emission by **complex systems** into their **environment**.

1970

MACHINE (Recursion) ²⁾

A machine able to pick up and understand its own **outputs**.

This is the basic condition for **organizational closure**. It means that once an impulse has entered the machine, it remains active – or potentially active – within it through a defined **op-**

erator. The **action** of the **operator** on the initial impulse generates a **meaning**. Various **operators**, when conjugating their **action**, may generate a behavioral **algorithm**.

von FOERSTER, quoting PIAGET, reminds us that **action** is a pre-condition for **perception**, while in turn **perception** becomes a pre-condition for new **action**. There is a kind of upbuilding **circularity** – or better, *spirality* – of the cognitive **process**.

Moreover, it seems that the whole universe of evolving systems could be viewed as a multi-level **embedding** of recursive machines.

→ **World engine (A. LOTKA)**.

1971

MACHINE (Sequential) ²⁾

According to S. LIPSCHUTZ, a complete sequential (or finite **state**) machine "... consists of five things:

- A finite **set A** of **input symbols**
- A finite **set S** of internal **states**
- A finite **set Z** of **output symbols**
- A next-state **function f** from $S \times A$ into S
- An **output function g** from $S \times A$ into Z " (1976, p. 124).

Compare with the **finite automaton**, which modifies its internal **states**, but produces no **outputs**.

1972

MACHINE (Social) ²⁾ - ⁴⁾

This concept is discussed by J.L. VULLIERME, who states that: "If one day really thinking artificial machines should appear, they will necessarily be socialized machines, able to communicate with other machines, in order to construct their own **references**, through cross-referencing with others" (1990, p.153).

This emphasizes **emergence** through interacting **combinatorics**, i.e. **networking**, which seems to be the very basic bedrock of social **efficiency**.

It could be said that any **society**, of any kind, is somehow similar to a **connection machine**.

1973

MACHINE (Trivial) ¹⁾

A machine whose **behavior** does not change in **time**.

H.von FOERSTER warns that: "The term "machine" in this context refers to well-defined functional properties of an abstract entity rather than to an assembly of cogwheels, buttons and levers, although such assemblies may represent embodiments of this abstract functional entity". He adds: "A trivial machine is characterized by a one-to-one **relationship** between its "input" (**stimulus, cause**) and its "output" (**response, effect**). This invariable **relationship** is "the machine". Since this **relationship** is de-

termined once and for all, this is a **deterministic** system; and since an **output** once observed for a given **input** will be the same for the same **input** given later, this is also a predictable system" (1981, p.201).

The basic characteristics of a trivial machine are the following:

- it is fully **deterministic** or **behavior** programmed
- it has a limited number of possible **states**
- its **behavior** is completely predictable
- its **behavior** does not depend from the whole **set** of its past **states**
- it has no **autonomy**
- it cannot self-organize

Until now most human-constructed machines are trivial. von FOERSTER observes jokingly that, according to the famous **Laplacian deterministic** formulation, the world would be a trivial machine! (1992, p.62).

1974

MACHINE-LEARNING SYSTEM (Elements and Basic Functions of) ⁵⁾

T.ÖREN describes the elements and basic functions of such a machine, as follows:

ELEMENTS	BASIC FUNCTIONS
Knowledge acceptor (of exogenous and endogenous knowledge)	Knowledge acquisition from the environment or from the system itself (for self-monitoring systems)
Knowledge operationalizer	Knowledge transformation for knowledge internalization (or operationalization)
Postprocessor of learned knowledge	Enhancement of learned knowledge: Organization Transformation Evaluation
Memory unit	Knowledge storage
Knowledge locator	Finding knowledge relevant to a task
Performance element	Use of the learned knowledge to perform a task

(1990, p.23).

While one must be careful using certain terms (as for example "**memory**"), it is interesting to see, how, as time goes on, the "machine" on its ways towards "intelligence", acquires the same (or similar) **functions** as natural intelligence... or how we are learning about the second one by studying the first one.

Let us remember anyway that ÖREN tends to assimilate "**knowledge**" with "**information**" and that **knowledge** is used in this context in the sense of what an **expert system** contains and how it can be used: see B. ZEIGLER on "internal **representation**" (1976).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1975

MACRO-, MEGA-, MICRO-^{2) - 3)}

There is much imprecision and even some confusion in the use of these prefixes. S. ARIETI, for example, define the "mesocosm as a world of middle dimensions" and adds: "... life exists in the mesocosm. In order to originate and evolve it had to incorporate mesocosmic laws" (1965, p.114).

ARIETI thus senses that we are somewhere near the middle of the magnitude's **scale**, let us say in between the cosmos and the quarks. Could this not be the superlative form of anthropocentrism?

J.de ROSNAY calls "**macroscope**" the conceptual "instrument" that he proposes to use to observe ARIETI's mesocosm.

We should try to unify terminology and not create too many competing terms. This author proposes to abandon "mesocosm", which never entered common use since 1965 and to use:

- micro- for those **levels** that must be indirectly observed with the help of microscopes, Geiger counters, etc.
- macro- for our natural **level** of **observation** through our senses;
- mega for those **levels** that must be indirectly observed through telescopes and astrophysical instruments... or studied on basis of very general and long-term **observations** and theories.

Micro-, macro- and mega- also define **levels** of **aggregation** or **disaggregation**, as for example macroeconomics versus microeconomics, or macrobiology vs microbiology.

Such a scale is useful in dynamics, helping us to understand the existence of **short, medium** and **long-term processes** and the way the first ones are **embedded** within the last one. Of course, this **scale** is anthropocentric. We merely need to be conscious of this, in order to perceive and understand the relativity of our spatial and temporal **perceptions**.

1976

MACRODETERMINACY^{1) - 2)}

"The situation which occurs in a system that may be treated as **deterministic** at the higher **levels** (or at the **level** of the **whole** itself) but where the lower-order **components** of the system may not admit to **determinacy**" (adapted from J. SUTHERLAND, 1973, p.42).

SUTHERLAND comments: "... this may mean that the system itself is capable of **prediction** (or amenable to some sort of **finite-state system analysis** technique) even though we cannot treat the **parts** or lower-order **components** as **deterministic**". This reminds of J.von NEUMANN's reliable systems made from unreliable **components**.

At the time SUTHERLAND offered his definition (1973), research on **chaos** had just made a start. It is now becoming clear that **micro-level** relative **indeterminacy** is the result of the multiplicity of independent local causes within the system. This is the background reason why, as stated by the same author (in relation to **human systems**): "... when systems under treatment begin to depart from the most simple kind of **mechanisms**, both our **mathematics** and our logic (even coupled with a large computer) fail to be able to manage the **interactions** and componential permutations of **behavior** potentially available" (p.45).

1977

MACRON^{1) - 2)}

"A multiple globally stable **regime**" (E. JANTSCH, 1976, p.72).

E. JANTSCH assimilates macrons to **dissipative structures**. According to R. ABRAHAM, such **BÉNARD phenomena** are macrons. A **complex system** may transit through different macrons, during macrodynamic **processes**, as explained by R. ABRAHAM (1976, p.134 - 148).

These transitions are "**catastrophic**" in THOM's sense.

ABRAHAM distinguishes (mainly for practical purposes) three basic types of macrons: physical, chemical and electrical. Biological systems present combinations of these three types, which constitutes the bases for **morphogenesis**. He states that "... the mathematical description of a macron is an **attractor**" and "It is actually the theory of **transitions of attractors**, or **catastrophes**, as developed by René THOM (1973), which is the basis for the geometry of macrons..." (p.140).

The subject is related to W. d'ARCY THOMPSON famous work "On Growth and Form" (1916), to C. LAVILLE's study of the "Mécanismes biologiques de l'atome à l'être vivant" (1950 - A quite unknown masterwork on **helixes** and energetic **whirls**' role in **morphogenesis**) and to A. TURING's research on "A chemical basis for biological **morphogenesis**" (1952), itself related to the BRAVAIS brothers work on phyllotaxis (1837).

The - supposedly - static "**objects**" we do observe at our temporal **scale** of **observation** are, in fact, a snapshot of macrons. A good example are apparently immutable geographic features: oceans, mountain ridges, etc.

1978

MACROSCOPE³⁾

"A symbolic tool, made of a set of **methods** and techniques taken from very different disciplines... to give a new (global) look into nature, society and man" (1975, p.10).

J.de ROSNAY states that the macroscope is not to be used to see farther away, or to blow up, but to observe that which is at the same time too big, too slow and too complex for our direct **perception**. As an example he gives human society "that gigantic **organism** totally invisible to us".

He adds: "In relation to society, we are today these particles and we must focus our attention on these systems which include us in order to understand them better, if they are not to destroy us. **Roles** are reversed: it is no more the biologist who observes the living **cell** with a microscope; it is the **cell** itself which, through the **macroscope** examines the **organism** which contains it" (p.11).

Of course, as noted by H.T. ODUM, the macroscope is **systems science**, used for "acquiring ways to discern the broad future and **mechanisms** of a system of **parts**" (1971, p.10). ODUM proposes the following way for the practical use of the so-called macroscope:

- "1. Survey, identify, classify
2. (Use a) detail eliminator. Prepare a **network** diagram of **compartments**
3. Determine **flows**
4. Simulate by a simplified **circuit model**
5. Experiment and manage (through a) demonstrator of overall **function** principles
6. Manage with **actions**" (Ibid.).

We should add: "Observe results" and, "Recycle the whole **process** all over again, and again.

1979

MACROSCOPIC and MICROSCOPIC^{1) - 2) - 4)}

There is a basically thermodynamic relation between the statistical microscopic **level** and the **deterministic** macroscopic **level** of **behavior** of a system. (I. PRIGOGINE, 1978, 1/1).

Macroscopic **determinism** expresses the global coherence **constraints** surging from, and imposed to the microscopic **behavior** resulting from **interactions**. This is for example what happens when a gas is enclosed within a container: molecular stochastic movement is translated at the macroscopic **level** as global conditions of temperature, volume and pressure.

This correspondence between microscopic and macroscopic **behavior** also seems to be the hidden condition of Adam SMITH supposed "invisible hand" in economic **processes** or generally, of the **emergence** of great conceptual or ideological currents.

1980

MACROSTATE^{1) - 3)}

"An equivalence **class** of microstates, determined by the equivalence relation "is **microscopically indistinguishable**" (F. HEYLIGHEN, 1990b, p.489).

HEYLIGHEN states: "To really distinguish microstates belonging to the same equivalence **class**, we would need to determine additional **variables**. Those **variables**, however, are "hidden" for the macroscopic **observer**" (ibid.).

This **concept** is closely related to the one of **level**, which is the **observation** setting where the corresponding equivalence **classes** do appear. And, of course, "**macroscopic**" is a relative notion.

1981

MAGIC BULLET ¹⁾

"Some invention that, when widely distributed, will make a **problem** disappear without leaving more **problems** in its wake" (S. FULLER, 1995, p.53).

FULLER asks: "Why do scientists fall so easily into the trap of thinking in terms of magic bullets shooting at magic targets?" In his opinion the main reason is that "scientists are consistently taught to think about science as quite different – and perhaps even independent – from the rest of society" (ibid)... not to speak of the **environment** in general.

Tinkering merely with a proximal cause, or even only with some immediate **effect**, is a result of the nonsystemic ivory tower style of work, proper of many specialists, combined with the cultural conviction that "Science" is all-powerful.

1982

MAGICAL NUMBER SEVEN ^{2) - 3)}

The maximum number of features that can be perceived in a discriminated way.

Actually, G.A. MILLER, who introduced the notion, is somewhat more tolerant about it and writes about "The magical number seven, plus or minus two", as defining "some **limits** on our capacity for **processing information**" (1956, p.81-97).

Basing himself on numerous experiments, MILLER came to the following conclusions:

"... the **span** of absolute judgment and the **span** of immediate **memory** impose severe limitations on the amount of **information** that we are able to receive, **process**, and remember.

"... the **process** of recoding is a very important one in human psychology (and)... in particular... linguistic recoding... that seems to me to be the very lifeblood of the thought **process**.

"... the **concepts** and measures provided by the **theory of information** provide a quantitative way of getting at some of these questions. The theory provides us with a yardstick for calibrating our **stimulus** materials and for measuring the **performance** of our subjects" (p.79-80).

MILLER's views are significant for various systemic concepts and **models**:

- our capacity to discriminate our **perceptions** are severely limited and we are easily exposed to **information overload**.
- it may be more useful in some cases at least to train ourselves in the **perception** of complex compounded **stimuli** units, possibly synthesized through various **levels** (for instance micro-, macro- and mega-, or **hierarchical** as in H. SIMON's "**Hora and Tempus parable**").
- the *well organized perception of patterns of correlations* and the construction of **gestalts** should be very useful.

1983

MAGNITUDE ⁵⁾

In **Systems Dynamics**, the quantification of some **elements** ("levels") in the system.

In **Systems Dynamics**, the quantities of stored **elements**, or registered orders, or members in **populations**, for instance, are magnitudes.

This meaning of the term should not be confused with the mathematical or the astronomical one.

1984

MAINTENANCE CONDITIONS of a SYSTEM ¹⁾

According to L.von BERTALANFFY, the maintenance of a system "involves continuous **change** of the systems of next lower order (*level*): Of chemical compounds in the **cell**, of cells in multicellular **organisms**, of individuals in super-individual life units. It was said, in this sense ... that every organic system is essentially a hierarchical **order of processes** standing in **dynamic equilibrium** ... We may consider, therefore, organic **forms** as the expression of a **pattern of processes** of an ordered system of forces. This point of view can be called *dynamic morphology*" (1969, p.81).

Generally the system maintains itself "not because of the absence of degradative **reactions** but because the synthetic and degradative **reactions** are proceeding at equal **rates**" (ibid).

1985

MAINTENANCE ENERGY DEMAND ¹⁾

Any system needs **energy** to maintain its internal **organization**. This demand of **energy** is greater in proportion to the **level of organization** of the system, which is in accordance with the **thermodynamics of dynamic equilibrium systems**, as established by I. PRIGOGINE.

This has to see with the system's **self-reproduction**: **Errors** must be repaired and this **process** includes a **cost**, which in last resort is always an **energy** one. Even the plan to avoid **errors** has its own **cost**.

Strangely enough, economy is one discipline where this concept is nearly completely forgotten: repairs are generally accounted for as an increase of general product, and, at the national **level**, there exists no patrimonial accounting of natural **resources**, whose natural replacement **cost** – when replacement is possible is not taken into account (Save in New Zealand, which recently introduced such accounting).

1986

MALTHUS "LAW" ¹⁾²⁾⁴⁾

According to Thomas MALTHUS, British economist (1766-1834), any **population** tends to grow limitlessly – and sometimes in an exponential way – until it reaches the upper **limit** of the available **resources**, mainly food. This may lead to catastrophic **population** crashes.

This is not really a "law", as frequently stated. In the case of human **populations** it has never been rigorously established and is widely doubted and criticized. It implies various hidden **assumptions**.

First, it could be true only for a system living in an isolated **environment**, i.e. for a **population** unable to colonize new territories. This could or course become the case for the human population in global terms on this planet.

Secondly, and again in the case of human populations, it does not take in account technical **progress**, which repeatedly allowed for new and better use of existing **resources**.

Thirdly, it is not evident that human population should necessarily grow forever. Leaving apart the possibility of massive **pandemics** (which could be considered a natural "malthusian" **mechanism**), the most recent **trends** in human **population growth** seem to indicate that there is a natural **regulation mechanism** at work: Human population explosions could be a transitional **phenomenon**, as in more and more countries, birth **rate** seems to decline, as well as death **rate**, in relation to material **development**.

In short, the final **validity** of the Malthusian **model** has not, until now, be either proved or disproved for the global human population on a planet whose **resources** are anyhow limited. It could be considered a caveat.

1987

MAN AS A PREDATOR ¹⁾⁴⁾

Man is obviously and by far the most accomplished predator in this planet.

He lives off the animal and the vegetal world on a massive **scale**, as no past or present other species has ever done.

He has become a planetary **parasite**, much more than a **commensal** or **symbiont**, and the most important and global accelerator of **entropy** in the whole **ecosphere**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

He is also living off the geological spare-boxes of fossil **energies** and raw materials, sending enormous quantities of **waste** into planetary **sinks** that are becoming less and less able to cope with such a massive and in many case un-recyclable **flow**.

In fact, he is using the planet as a gigantic **commons** in the meaning of Garrett HARDIN (1968) and not giving any sufficient heed to the disquieting **signs** of the negative consequences of his ways.

It is quite probable that the global survival of the **man-planet system** will become the main problem during the 21st century.

→ **Predatory behavior**

1988

MANAGEMENT ⁴⁾

The direction and administration of an **organization**, estate or business.

The concept, in spite of an enormous quantity of publications of widely different scope and kind, remains quite fuzzy.

Various viewpoints appeared since the mid-19th Century, when management was practiced in a intuitive and generally authoritarian fashion.

So-called scientific management appeared next, with FAYOL and TAYLOR, whose views largely reflected the **deterministic** and **mechanicist** orientation of 1880-1930, with a dominant interest in quantitative **efficiency** and **maximization** of operative results.

Later on, economic and social influences seeped into management theories, according to the growing influence of working classes and the problems spawned by the big depression of the thirties.

The present situation seems to herald new and very deep conceptual **changes**, originating mainly in the growing **instabilities** resulting from accelerated technical **change** (including globalization by computers and telecommunications); differential **evolution** in different economic zones; **population explosion** (and, within few decades, universal **ageing**); and most recently the growing ecological problems.

The first result has been an explosion of partial solutions promoted by the so-called "gurus", most of them addressing **symptoms** more than **causes** and, in some cases, proposing "ways to do right the wrong things" (R.L. ACKOFF, 1995, p.43-6). In management, we are obviously suffering of overspecialized myopia.

It could not be said that systemics has completely resolved this issue. However, the global approach is powerfully present in P.B. CHECKLAND's **Soft Systems Methodology**; in J. WARFIELD's **Interactive Management** (and complementary **Global Design Technique**); in B. BANATHY's **Co-participative Design**; M.

JACKSON's **Total Systems Intervention** and in J.A. JOHANNESSEN's **Heterarchic-holographic model**... to name only some very significant proposals.

Management cannot anymore be stripped of its more general human and ecological dimensions and becomes a most important and all-embracing issue in systemics.

1989

MANAGEMENT and SYSTEMS MORALITY ¹⁾⁴⁾

J.van GIGCH tackled this subject in his book on "Applied General Systems Theory" (1978, p. 145-170). His views have been much influenced by C.W. CHURCHMAN's ones.

van Gigch writes: "In the past, science and **design** could remain value free... the optimum dictated solely by the "technological imperative" by which efficiency meant to find the **solution** with the lowest technical **costs**" (p.145)

However now "technological **efficiency** becomes subordinated to social efficiency". This implies that "to determinate the morality of a system's design is to evaluate the **effects** of the planner's intervention on those for whom the plan is intended. It involves a consideration of :

- 1- value measures-costs and utility
- 2- a science of values
- 3- the **ethics** of **spillover** effects
- 4- the ethics of causing **changes**
- 5- the ethics of **goals**
- 6- the manager's ethics
- 7- social **responsability**
- 8- the conservation ethics
- 9- consumerism and consumer protection
- 10- safety and product liability "

These points are extensively developed by van Gigch in his book. It is generally very important to understand that many of the terms used as for example: costs, utility, values, goals- have very variable psychological overtones (or "undertones"?) according to the different people who use them: managers, shareholders, **stakeholders**, outside **observers**.

The very signification of the concepts of morality and value needs to be deeply scrutinized.

→ **Clanthink; Decision making; Ethics and morality; Rights and responsibilities; Trade off decision**

1990

MANAGEMENT CYBERNETICS ²⁾

A cybernetic insight and **methodology** of management" particularly dominated by the **machine analogy**" (M.C. JACKSON, 1992, p.103).

JACKSON explains: "The starting point for the management cybernetic **model** of the or-

ganization is the **input-transformation-output schema**. This is used to describe the basic operational activities of the enterprise. The **goal** or **purpose** of the enterprise is, in management cybernetics, invariably determined outside the system (as with a first-order **feedback** arrangement). Then, if the **operations** are to succeed in bringing about the **goal**, they must, because of inevitable **disturbances**, be **regulated** in some way. This **regulation** is effected by management. Management cybernetics attempts to equip managers with a number of tools that should enable them to **regulate operations**. Chief among these are the **black box** technique and the use of **feedback** to induce **self-regulation** into **organizations**. The latter is often supplemented by **strategic control**, based on **feedforward information**, and external **control**. Management cybernetics makes little use of the more complex, **observer-dependent** notion of **variety**" (Ibid).

This is the point. Management cybernetics is basically a product of the so-called **1st cybernetics**, still basically **mechanistic** in its outlook. As observed by JACKSON such **models** "clearly lend themselves to autocratic usage by those who possess power".

However, this type of management should not be confused with S. BEER **Viable System Model**, much more inspired by von FOERSTER's et al **Cybernetics of 2nd order**, the "cybernetics of **observing systems**".

1991

MANAGEMENT (Hierarchic vs. heterarchic) ⁴⁾

G. DYER proposes the following differences between these two types of management:

"Hierarchic"	"Heterarchic"
Position-centred	Person-centred
Repetition oriented	Creativity oriented
Efficiency seeking	Innovation and efficiency seeking
Rules oriented	Results oriented
Rewards adherence to rules	Rewards outcomes
Information tightly channeled through formal structure	Maximize communication flow
Internally focused	Externally focused: alliances and coalitions
Uniformity	Diversity
Perception of a work-force	Human resource management
Top down	Bottom up

DYER, whose choice is **heterarchic** management, writes: "Devolution, decentralization and delegation of responsibility and power has become essential. **Matrix** - rather than bureaucratic - **structures** are now seen as much more desirable. **Control** is much more open-loop with semi-autonomous and self-managing teams common-place. The **role** of the manager or leader is now to develop an inspiring vision, to manage by example rather than to exercise **control**" (1992, p.1192).

1992

MANAGEMENT (Human Systems) ⁴⁾

M. ZELNY has characterized Human Systems Management in the following terms:

"1) Human systems are to be *managed* rather than analyzed or designed. HMS is not systems analysis or *design*".

(Note: In recent years, a new **concept of co-participative design** has emerged, which escapes from the limits of authoritarian and prescriptive **design**);

"2) Management of human systems is a **process of catalytic reinforcement** of dynamic **organization** and bonding of individuals. HMS does not design a **hierarchy of control** and command;

"3) The **components** of human systems are *humans*. HMS is not **general systems theory** but a general theory of human **organizations**;

"4) The integral **complexity** of human systems can be lost through the **process** of mathematical simplification... HMS is not **operation research**, econometrics or applied mathematics;

"5) The **interactions** between individuals are not those of electronic circuitry, **communication channels**, or **feedback loop mechanisms**. HMS is not **cybernetics** or **information theory of communication**"

(Note: i.e. is not **mechanicist cybernetics** of the first order, but could be aided by von FOERSTER 2nd order cybernetics);

"6) The order of human **organizations** is maintained through their structural **adaptations** under the conditions of environmental **disequilibrium**. HMS is not the theory of general **equilibrium**;

"7) the **concepts** of **optimization** and optimal **control** are not meaningful in a general theory of human systems. Human aspirations and **goals** are dynamic, multiple and in continuous **conflict**. Such **conflict** is the very source of their **catalysis**. HSM is not optimal **control** theory or theory of **conflict** resolution;

"8) The **inquiry** into human systems is **trans-disciplinary** by definition. Human systems encompass the whole **hierarchy** of natural systems: physical, biological, social and spiritual. HMS is not **interdisciplinary** or **multidisciplinary**, it does not attempt to unify scientific disciplines, it transcends them" (1977, p.27).

All these ideas are consonant with, for instance, P. VENDRYES **concept** of **autonomy**, i.e. the capability of a system (biological, social) to establish its own behavioral laws, and with MATURANA and VARELA's **autopoiesis**.

1993

MANAGEMENT in systemic terms ^{1) - 4)}

R.L. ACKOFF ironically observed recently that "managers suffer from panacea **overload**" (1994, p.43-6).

He argues that popular management panaceas do not work, most of the time, because they are applied **anti-systemically**. His diagnosis is as follows: "These failures have two principal sources. First, they manipulate the **parts** of systems without regard to how their manipulations affect the **whole** through **interactions** of the **parts**. Second, they tend to do the wrong thing righter rather than the right things" (p.43).

ACKOFF proposes the following systemic **rules** for management of an **organization**:

"1. Allow any **part** to change itself in any way that does not affect the performance of any other **part**, or the **whole**, provided the **part** has the **resources** necessary to make the **change**.

"2. If the **change** a **part** wants to make affects one or more other **parts** and either improve or does not affect the performance of the **whole**, it is allowed to make the **change** if it obtains the agreement of the affected **parts**.

"3. If it does not obtain the agreement of the affected **parts** the issue can be taken for resolution to the lowest **level** of management at which the **parts** converge.

"4. If a **part** has the necessary agreement but does not have the necessary **resources** to implement the **change**, it must try to obtain the **resources** it requires from the lowest **level** of management that has the **resources** it requires.

"Adherence to these **rules** requires continuous **monitoring** - a function that can appropriately be assigned to the **organization's planning** unit. It should be noted that these **rules** also operationalize the meaning of "empowerment" (p.45).

All this is about maintaining the internal **coherence** of the **organization**. More must be said about its **interrelations** with its **environment**.

ACKOFF's principles do refer to the internal management of the **organization**. However, even if perfectly managed in function of the **goals** and needs of the **organization** and its members, the final result can be disastrous if the external global conditions of its **survival** are not permanently monitored and taken into account. Every member of the **organization** should be duly informed and made conscious of this very fundamental aspect and correspondingly act in a responsible way.

1994

MANAGEMENT (INTERACTIVE) ⁴⁾

"A system of management invented explicitly to apply to the management of **complexity**" (J. WARFIELD, pers. com.).

WARFIELD states: "It is intended to be applied intermittently in **organizations**, to enable

those **organizations** to cope with **issues** or **situations** whose scope is beyond that of the normal type of **problem** that **organizations** can readily solve.

"I.M. is related to the ..."Science of **Generic Design**" which provides a scientific basis for the practice of I.M." (Ibid).

The characteristic steps of I.M. are"

"- Definition of the **situation** or **issue**: including

- 1) Approach to **complex issue**;
- 2) Exploration, i.e. **learning** more about the complex **issue**, and
- 3) Definition of the complex **issue**
- 4) Creation of several alternative **designs** for resolving the **situation** or **issue**
- 5) **Choice** of the alternative to be implemented

This will be achieved through the following phases:

- "- The **Planning** phase
- "- The Interactive Workshop Phase
- "- The Follow-up Phase

("Iterative application of the three phases will frequently occur").

WARFIELD also states: "IM **roles** are defined for both the supplier of IM services and the client **organization**. The **roles** are designed to achieve specific **objectives**, and to provide a compatible "cast" for the IM "drama". All specified **roles** must be filled. **Role** specifications are intended to provide quality **control** to IM use" (1995c).

Among the most important techniques used WARFIELD cites: **Nominal Group Technique**, **Interpretive Structural Modeling**, **Field Development**, **Profile Development**, **Ideawriting**, **Delphi** and **Tradeoff Analysis**.

(For complete information see J.N. WARFIELD, 1989, 1990 and 1995a)

1995

MANDALA ¹⁾

An Oriental complex design inscribed in a circle and symbolizing the universe.

The mandala has been used by some systemists (as St. BEER) to represent complex **wholes** and generally symbolize totality and **complexity**.

1996

MANIFEST versus HIDDEN ¹⁾

A **distinction** to be made between visible **states** and/or **behavior** of a system and other ones, which are not so readily apparent.

Very frequently, **deciders** of all kinds find themselves trapped in too narrow views about the **situations** they must meet. One of the most common delusions is the supposedly independent character of some aspects of a **situation** or **parts** of a system, when **interactions** remain unknown and are believed inexistent.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Another one is the incapacity to imagine **changes** that would not be **determined**, or worse, determinable at will. As stated by J. FOURASTIÉ, ignorance of ignorance is worse than simple common ignorance. Or, in G.De ZEEUW's word, we must become aware of **in-visibility**.

Systemics and cybernetics contribute efficiently to this important issue through the use of concepts and **models** about **complexity** and **complex change**.

1997

MANIFOLD⁵⁾

"A **class** with sub-classes" (T. & W. MILLINGTON, 1971, p.139).

T.A. and W. MILLINGTON give the following example: "A plane is a two-dimensional manifold of points, because it is the **class** of all its points, and each is specified by two coordinates, (x,y)" (Ibid.).

This implies that any **element** of the manifold is permanently recognizable and distinguishable from any other.

1998

MANIFOLD (Invariant)^{2) - 5)}

"A surface containing the **phase space** of a dynamical system which has the property that orbits starting on the surface remain on the surface throughout the course of their dynamical **evolution**" (S. WIGGINS, 1988).

WIGGINS adds: "...the **set** of orbits which approach or recede from an invariant manifold M asymptotically in **time** under certain conditions are also invariant manifolds which are called the **stable** and **unstable** manifolds respectively, of M. **Knowledge** of the invariant manifolds of a dynamical system as well of the **interactions** of their respective **stable** and **unstable** manifolds is absolutely crucial in order to obtain a complete understanding of the global **dynamics**" (Ibid.).

While previous to and independent of the study of **chaos**, the subject has now become an indispensable tool for the modelization of **turbulence** and **chaos** in mathematical terms.

1999

MANIPULATION^{1) - 4)}

An **action** of a system on its **environment** aiming at changing it in a hopefully favorable way.

Manipulation power increased throughout **evolution** of **living systems**. One of the most important effects of **sociality** has been the collective multiplication (not merely addition) of manipulating power over the **environment**. This is readily manifest even in insect societies, and also in **co-evolutive phenomena**.

However, manipulation must remain compatible with the maintenance of **environmental fitness** and **survival** value of the system, if it is not to become counterproductive.

The results of **socio-technical** manipulation applied on any **environment** should thus be carefully considered and closely monitored.

2000

MAN-MACHINE SYSTEM

→ **System (Man-machine)**

2001

MAP (Mental)^{2) - 3)}

A mental **model** we **construct**, knowingly or not, of some **part** of the world.

Of course, physical maps, or **models**, or even a sculpture, are originally mental maps, translated within **artifacts**.

S. BEER describes a map as: "the **pattern** of something, represented with much attenuation of **variety**, but with its significant **elements** preserved" (1974, p.37).

Still, a map is a kind of **metaphor**. It corresponds however to a very general type of **processes** in **neural networks**, even in animals: We register, interpret and retain experiences that can be retrieved when needed, let us say for instance, finding our way back home. As expressed by M. BODEN: "The map is used to generate an indefinite number of very useful "coulds" and "cannots". She adds this very important observation: "A list of landmarks is less useful: like the parroting of the first seven square numbers, it does not generate any new notions" (1990, p.47).

This means that a good map must include **information** about **interrelations** and dynamic **interactions** similar to G. KLIR's **source system**.

On a higher level of **abstraction**: "Theoretical maps help scientists to seek, and find, things never glimpsed before... For example, MENDELEEV's periodic table suggested to 19th Century chemists that unknown **elements** did exist, corresponding to specific gaps in the table".

However "A new theoretical map may not be universally welcomed, because yet-unseen **spaces** can be hard to imagine" (p.48).

This explains at least in part the resistance to new **paradigms**, and specifically to the **systemic paradigm**.

2002

MAP TERRITORY RELATION^{2) - 3)}

A. KORZYBSKI's "map territory" **metaphor** is fundamental to the **understanding** of **homomorphisms** and **isomorphisms** in **General Systems Research**.

KORZYBSKI stated: "Two important characteristics of maps should be noticed. A map is *not* the territory it represents but, if correct, it has a *similar structure* to the territory, which accounts for its usefulness" (1933, p.58).

Thereafter, KORZYBSKI transfers this **understanding** to **languages**: "If we reflect upon our **languages**, we find that at best they must be considered *only as maps*. A word is *not* the **object** it represents; and **languages** exhibit also this peculiar **self-reflexiveness**, that we can analyse **languages** by linguistic means. This **self-reflexiveness** of **languages** introduces serious complexities, which can be solved only by the theory of **multiordinality**" (Ibid.).

That the word is not the **object** is made perfectly clear by G. BATESON's example: "The word 'cat' cannot scratch us" (1973, p.153) and also from the following humorous A.N. WHITEHEAD's comment, quoted by KORZYBSKI: "The appeal to a **class** to perform the services of a proper **entity** is exactly analogous to an appeal to an imaginary terrier to kill a real rat" (1933, p.247).

As to theory of **multiordinality**, it is quite close to RUSSELL's theory of **logical types**.

Confounding the "map" with the "territory" leads generally to dire consequences, as well as using an incorrectly structured "map", whether geographic, linguistic or conceptual. The subject has also been reworked by H.von FOERSTER through his **Cybernetics of 2d order** (1981).

2003

MAPPING²⁾

The **process** of coupling two **sets** in a one-one correspondence.

St. BEER gives the very simple example of creating such a one-one correspondence between the 26 letters of the alphabet and the numbers 1 to 26 (1968, p.107).

While purely abstract mapping may be **isomorphic**, when we try to model **concrete systems**, "... in practice the mapping will be **homomorphic** - able to preserve some **structure**, but committed to losing some **information**. Thus our account of nature is 'true', but defective, and our account of such characteristics of nature as causation and law will change with the linguistic mapping we choose" (p.121).

Any **model** we do construct of any **part** of our **universe** is in some sense a mapping, and necessarily a merely **homomorphic** one, and: "The **variety** of the image system obtained with a **homomorphic** mapping is, of course, smaller than the original one" (R. VALLÉE, 1993b, p.75). It is essential for our conceptual (and possibly even mental) sanity to understand this and consequently, to relativize our **knowledge**.

Mappings are useful for the exploration of the interconnections and eventual **transformations** of the **contents** of the **set** of the interrelated items.

2004

MAPPING (Functional) in networks ²⁾

M. CAUDILL comments: "A **neural network** learns the **mapping** base on a collection of examples of the **relationship**, rather than requiring the formal equation as a computer would (M. CAUDILL, 1994, p. 19).

2005

MARGINAL VALUE THEOREM

→ Foraging theory

2006

MARKER ²⁾

A non-ambiguous **sign**, used in a **model** to represent a specific **element**.

J.von NEUMANN states: "A marker which can appear in ten different forms suffices by itself to represent a decimal digit" (1958, p.6). Of course, such a marker is really a collection of ten markers.

In case of using **digital** markers (0, 1) if one wants to represent a decimal digit: "A group of three two-valued markers allows 8 combinations; this is inadequate. A group of four such markers allows 16 combinations: this is more than adequate. Hence, groups of at least four markers must be used per decimal digit" (Ibid).

A coherent collection of markers, when given stable and precise values, constitutes a base for a **code**. The dots and dashes Morse **code** was one of the first systems using combinations of digital markers.

2007

MARKOV CHAIN ²⁾

A sequence of neither purely **random**, nor purely **deterministic transitions** from one **state** to any other in a system.

Another interesting definition by K. KRIPPENDORFF: "The **behavior** of an **informationally closed** and **generative** system that is specified by **transition probabilities** between the system's **states**" (1986, p.47).

He adds: "The probabilities of a MARKOV chain are usually entered into a **transition matrix** indicating which **state** or **symbol** follows which other **state** or **symbol**. The order of a MARKOV chain corresponds to the number of **states** or **symbols** from which probabilities are defined to a successor. Ordinarily, MARKOV chains are **state determined**, or of the first order. Higher orders are **history determined**. An unequal **distribution** of **transition probabilities** is a mark of a MARKOV chain's **redundancy**, and a prerequisite of **predictability**" (Ibid)

→ ("Ergodicity").

I. PRIGOGINE and I. STENGERS state the three general characteristics of Markov chains: "Non-repetitivity, existence of long range **correlations** and spatial **symmetry** breaks" (1992, p.90).

Markov chains are "statistically reproductive" and correspond to **deterministic chaos** "intermediary between pure **randomness** and **redundant order**" (Ibid).

2008

MARKOV CHAIN ANALYSIS ²⁾

Markov chains can be used to produce **forecasts** in probabilistic terms, when a sufficient number of statistical **data** can be obtained about the **interrelations** between some **events**. This is done through the construction of a **Markovian matrix**, usable to detect statistical degrees of **correlations**.

The underlying assumption is that the observed **transition probabilities** reflect some lax, but general, **determinisms** binding some **events** to some others, according to variable circumstances.

2009

MARKOV SOURCE (mth order) ²⁾

"An **alphabet** of **events** in which the probability of occurrence of a given number of the **alphabet** is a **function** of the m preceding occurrences" (K. SAYRE, 1976, p.29)

This is the generalized case of the first-order MARKOV source, "one in which the identity of each successive **event** (each **output event**) is a probabilistic **function** of the **event** immediately preceding (a specific **input-event**)".

K. SAYRE adds: "The mutual convertibility of a single **alphabet information channel** (a cascade of **channels**) with its corresponding MARKOV source is guaranteed by the fact that both can be completely characterized by a conditional probability **matrix** of the same basic form" (p.29-30).

2010

MARKOVIAN MATRIX ²⁾

A matrix that represents all the possible **transitions** of a system from any **state** to any other one.

The Markovian matrix resumes the probabilities of transition from a **set** of **states** to another **set** of **states**.

2011

MARKOVIAN MATRIXES (Hierarchies of) ²⁾

Referring himself to Markovian chains and matrixes, J. Mc CRONE writes: "Exactly the same statistical methods could be used to drive a higher **level** of analysis" (1993, p.30).

In speech identification or **language** analysis for example: "Markov **modelling** (can) be used to calculate the probabilities not only of one frame (of sounds or letters) following another, but also of one word following another and so produce a **language model** that could work out whether a person had meant "two", "too" or "to" simply from the **context** of what had been said" (Ibid).

In other words, Markov chains or matrixes reflect the **constraints** within the system and could thus become an interesting tool for **re-constructability analysis**.

2012

MARKOVIAN PROCESS ²⁾

The sequence of **transitions** from **state** to **state** in a system.

In a Markovian process, such **transitions** are submitted to **transition probabilities** between different **states**. These probabilities can only be statistically established, since any **transition** toward some **state** depends only on the immediately preceding **state**.

However, after a great number of **transitions** the average values of the respective **transition probabilities** from any **state** to any other one tend to stabilize.

This is because systems of this type are made of numerous **elements** only more or less laxly controlled in the long run by **environmental** and/or internal conditions.

This type of **processes** was extensively described by W.R. ASHBY in his "Introduction to Cybernetics" (1956).

→ Transition (Rule-obeying)

2013

MARKOVIAN PROCESS (Order of a) ²⁾

J. WICKEN states: "In **communication theory**, **messages** are conceived as generated from **symbols sets** through stochastic **processes** know as MARKOV's chains, wherein the presence of one **symbol** might or might not affect the identity of the following **symbol**, according to the **grammar** of **transmission**. SHANNON (C. SHANNON & W. WEAVER, 1949) referred to this as the "residue of influence" of one **symbol** on another. The reach of this "residue of influence" defines the order of the Markov process. If the presence of one **symbol** has no influence on what comes next, one has identical conditional probabilities, $p(i/j)=p(j)$ for any assignment of it, and the Markov order of the process is zero. If it influences only the identity of the immediately following element or symbol, the order is one and so on.

"The Markov order of a sequence chain is in turn reflected in its **complexity** and **compressibility order**" (1989, p.141).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This concept had already been applied in a very interesting way by W.R. ASHBY in his "*Introduction to Cybernetics*", specially when used to describe a system (as defined by the **matrix** of its **states transitions**) able to produce a great number of **trajectories** (1956, 9/4 to 9/10).

In another sense WICKEN consider that "the **information** of a paragraph is certainly not reducible to SHANNON's **complexity** of letters on a page... We can't *compute* the **information content** of a treatise any more than we can *compute* the **information** content of an **organism** by a SHANNON-**complexity** analysis of DNA sequences" (p.142).

2014

MARKOVIAN SYSTEM^{1) - 2)}

G. PASK states: "The probability that a Markovian system will occupy any of its **states** at $t+1$, depends only upon its **state** at t , and probabilistic **transformation** P made up of fixed **transition** probabilities P_{ij} " (1961, p.42).

Thus, its **behavior** is **random** only in some sense: It is impossible to predict with total certainty the next **states** of the system, but the **matrix** of the fixed probabilities of **transition** between the different **states** gives us three important **informations**:

- the number of possible **states** is finite, however enormous it may be. In other words, the system is more or less **constrained** in ASHBY's sense.
- As the **transition** probabilities are *fixed*, some **states** are more probable and frequent than other ones. **Transition probabilities** are **constraints**, but they merely restrict, but do not suppress **randomness**.
- When the possible **states** are numerous, most specific **transition** probabilities become very small and nearly equi-probable. This consequently reduces **predictability**.

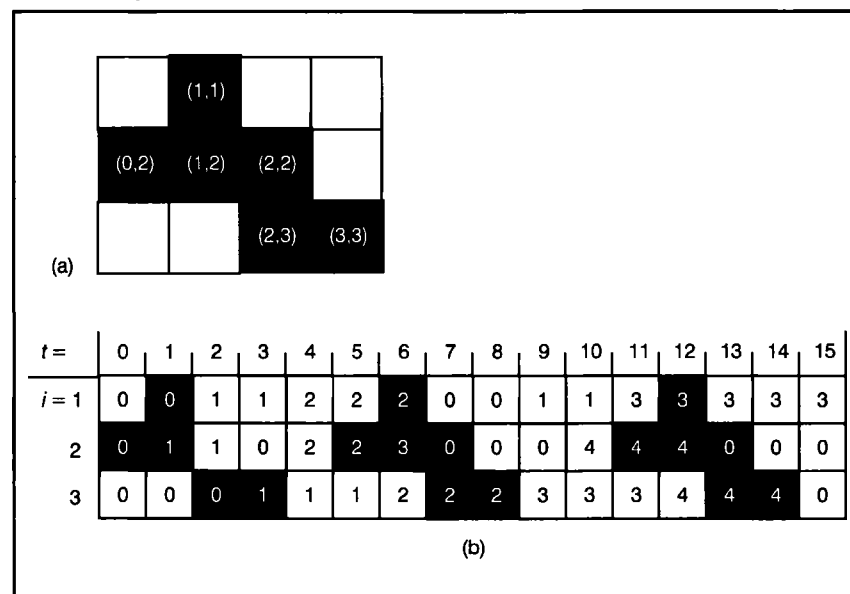
In PASK's words: "...an **observer** could perfectly well appreciate much longer-term **dependencies**" (p.43). The observer "could", but generally does not because the Markovian system has no *precise* **memory** of its past, but merely a general statistical one, which does not permit any secure **prediction**.

A **population's behavior** is generally markovian, as can be seen in some examples given by ASHBY (1956).

If, as observed by ASHBY some specific **state** of the system has zero probabilities of **transition** unto any other **state**, the system becomes stuck in this **state**. Such a **situation**, most of the time overlooked, generally implies its destruction.

PASK states moreover: "A **distribution** $P_i(t)$ is the *state* of the *Markovian system* and a sequence of **distributions** is a *behavior* of the *Markovian system*, conditional upon the chosen initial **state**" (p.44).

Figure: see entry **MASK**



Mask and Activity Array.

From G. KLIR: 1969, p. 117

And still: "By **analogy** with a **state determined** system any Markovian system reaches statistical **equilibrium**" and "In **equilibrium**..., regarded as an **information** source, it has a measurable **variety**. For n **states**, the maximum **variety** is $\log_2 n$, the **variety** of the **reference frame**, without any statistical **constraints**" (p.45).

Another significant property of the Markovian system is that it has no "**memory**". In PASK's words: "**Memory** or the ability to *learn* is not a property of the system, but of the **relation** between the system and an **observer**" (p.46). Indeed, it is the **observer** who construct the statistical **matrix**, after repeated **observations**. Even so, more **observations** could lead to a still different matrix.

A Markovian system is **metastable**: within its global **stability**, it undergoes stochastic jumps from **state** to **state**.

Under some **constraints**, Markovian systems become **ergodic**. Conversely, as observed by PASK, some **ergodic systems** include a "trapping" **state**, thus named because the system must end up in this single **state** (p.123).

A very important comment of PASK is that: "A system which is Markovian when observed in n **states** may not be Markovian if the **observer** combines some of its **states** and inspect a less detailed image" (p.125).

Thus, the 'lumping' of **states** (intentional or not), may very well deeply modify our **understanding** of the system.

2015

MASK²⁾

"A fixed **set** of sampling **elements**" (G. KLIR, 1967, p.194).

The mask is a partialized screen through which we observe specified **states** of the system. It is a kind of **variety reductor**. According to KLIR, he borrowed the term from A. SVOBODA (1963, 1964).

The concept is related to KLIR's "**Behavior system**", which "is defined by a **time-invariant relation** among selected present, past or future **states** of the **variables** in the **experimental frame**" (1988, p. 151).

The mask operates as a conceptual and formal **selector**.

It is an important tool of KLIR's **systems inquiring method** and **reconstructability analysis**.

KLIR describes the mask as follows: "The **pattern** of samples which is referred to as the mask, specifies those past, present or future **states** of the **variables** which are required to be a **part** of each sample. As such, the mask represents an hypothetical **memory structure** of the system" (1975, p.155).

KLIR moreover explains: "The problem of processing a given **activity** is related to a chosen mask (the mask represents something like the width of our view of the system) and may be stated as follows: Find samples of **activity** for all possible **time** positions of the chosen mask on the **activity**; express the **relation** between sampling **variables**, given by the obtained **set** of samples of **activity**, in the form of a **Boolean** equation, and solve the equation" (1967 p.194).

(for formalized aspects of the **method** see quoted papers)

see figure above

As observed by M. NOWAKOWSKA: "The **observer's** first choice is to define operationally the **phenomenon** which he studies. This **choice** depends on the **goal** of research, and

even for the same **goal**, the **choice** need not be unique". And: "... for the same **goal**, two researchers are likely to choose different **variables**. Whether or not the selected **variables** "cover" the **phenomenon**, in the sense that they provide **information** sufficient to attain the **goal**, is usually impossible to determine a priori with full certainty" (1986, p.62).

On the other hand: "Often the mask becomes changed in the **process** of taking the **observations**, i.e. one may decide to take some additional **observations**, of new **variables**, or of the **variables** observed until a given **time**" (p.66).

In other words, the **choice** and use of masks is partly **heuristic** and partly experimental.

2016

MATERGON²⁾ – 3)

"**Mass-energy**, of wave-corpuscular aspects, developing in **space-time** as differentiated systems".

The Spanish systemist R. RODRIGUEZ DELGADO introduced this synthetic concept, which reflects the artificial character of our mental disjunctions (of perceptive origin) when we conceptually separate **mass**, **energy**, **space** and **time**.

RODRIGUEZ DELGADO states: "The matergon concept offers a way to reach an integrated idea of natural, conceptual and artificial systems, connecting the philosophical **abstractions** with scientific and humanistic **models**" (1991, p.5-6).

The neologism seems useful as a permanent reminder that our way of splitting our **knowledge** of the universe into **categories** is probably a simple (or complex!) mental **artefact**, even if it is unavoidable.

RODRIGUEZ DELGADO explains at large the various aspects of the proposed concept in his last work (1997, p.43-51).

2017

MATERIALISM (Emergent)²⁾ – 3) – 5)

A theory that explains the relations between brain and mental **states** by considering the latter as a part of emerging **states** of the **brain** which however do not exist within the cerebral cells, the synapses, the dendrites or any other neural **element** (after R. RODRIGUEZ DELGADO, 1993a, p.258).

Mental activity depends upon the existence and good working order of the cerebral cortex: without this specific cerebral activity – different from the vegetative **functions**, which are controlled by other **parts** of the **brain** – it cannot exist.

The Spanish neurologist J.M. RODRIGUEZ DELGADO lists as follows the essential conditions of mental activity:

"1. A corporeal **structure** endowed with a normal physiology, able to provide oxygen, nutrients and other **elements** of cellular **metabolism** and able to eliminate the **wastes**.

"2. Sensorial **receptors**, which are the exclusive entries for the **information inputs** from within or without the **organism**.

"3. A functioning **brain**, endowed with the **mechanisms** needed for reception, circulation and emission of **messages**.

"4. **Organs** able to receive and express the orders and **messages** of the **brain**" (1993, p.297-8).

According to J.M. RODRIGUEZ DELGADO, emergent materialism is the most flexible hypothesis and at the same time the most helpful one for research on mental **phenomena** in terms of usual scientific techniques.

2018

MATHEMATICAL SYSTEM²⁾ – 3)

"A **set** of **objects**, with associated **rule** or **rules** of combination" (R. CARMICHAEL, 1956, p.4).

CARMICHAEL, a mathematician without known relation with systemics wrote, in 1956: "... any **set** of mathematical **objects**, which admits either (one or more) **rules** of combination of **elements** or **relations** among **elements** may be said to form a mathematical system. Systems, as so defined, underlie nearly the whole of mathematical science" (Ibid).

During the last 40 years, numerous mathematical developments relative to complex multicausal, mostly **nonlinear** and dynamic **inter-relations** have been introduced, creating new possibilities to modelize inter- and intrasystemic **relations** and complementing the traditional **models**. (See **catastrophe**, **chaos**, **fractals**, **fuzzy sets**, **graphs**, **percolation**, etc...).

2019

MATHEMATICAL TRUTH³⁾

A. RAPOPORT observed: "... mathematical truth, being established only with reference to propositions assumed to be true, cannot be shown to be true in the sense of scientific truth, that is, observationally or experimentally verifiable truth. Bertrand RUSSELL was not joking when he said that in mathematics we never know what we are talking about nor whether what we are saying is true" (1967, p.15).

The same point was made by A. EINSTEIN when he wrote: "As far as the laws of mathematics refer to reality they are not certain, and as far as they are certain, they do not refer to reality".

All this anyhow, does not need to be taken too hard: We just should remember that **models** – of any kind – are merely reflexions in human **brains** of (and on) a reality about which we cannot ever dream to attain absolute truth.

R. VALLÉE makes the point as follows: "Mathematics applies to physics because the **objects** and their properties recognized by experimental science in the physical world are *selected*, through **relations** that can be reproduced, in order to imply a mathematical definition which is amenable to calculation. Physical laws are merely the synthesis of the reproducible **relations** used for the definition" (1983b, p.563).

In some sense, mathematics are thus like an **inquiry** about the ways we make **models** of reality. When we start to look at reality in a different way, as we do as systemists, we are in need of new mathematical **models**, which are indeed appearing apace since 1965, and offer new ways to study systems **structures** and complex **dynamics**. Some older **models** also acquire new **meanings** and uses as for example **graphs**, **matrixes** and **binary algebra**.

2020

MATHEMATICS³⁾

A general overview of its relation to systemics.

According to A. KORZYBSKI: "From the point of view of **general semantics**, mathematics, having **symbols** and propositions, must be considered a **language**. From the psychophysiological point of view, it must be treated as an **activity** of the human nervous system and as a form of the **behaviour** of the **organisms** called humans" (1933, p.250).

KORZYBSKI considered mathematics "...a limited linguistic scheme, which makes possible great precision and **coherence** – but at the expense of such extreme **abstraction** that its applicability has, in certain ways to be bounded" (D. BOHM and F. David PEAT – 1987, p.8).

The same point was made by B. RUSSELL, who admitted that mathematics offers the appearance of **truth** because it is not saying what it is talking about: a comment that was echoed by A. EINSTEIN (see above).

In the same vein, K. BOULDING wrote: "... mathematics in any of its applied fields is a wonderful servant but a very bad master: it is so good a servant that there is a tendency for it to become an unjust steward and usurp the master's place" (1970, p.115).

All this justifies G. WEINBERG's caveat: "A degenerative disease sporadically afflicting the **general systems movement** is *hypermathematisis*: the generation of grand, sweeping and *valid* mathematical theories – often called "**general systems theories**" – which are as sterile as a castrated mule... because they can be applied to *anything* and thus to nothing: but they are doubly sterile because they are undistinguishable – on a mathematical **level** – from productive theories" (1975, p.68).

Mathematics, as a **language**, must necessarily take forms in accordance:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1/ – With the neural **organization** of the **brain**, still quite imperfectly known.

2/ – With the nature of the problems of which that **brain** becomes aware, as mental part of an **observer**. This is the reason why **nonlinearity** observed in **complex systems** tends to generate new mathematical tools.

This explains why *new* mathematics emerges frequently in synchrony with a new awareness of some **class** of hitherto undiscovered **phenomena**.

2021

MATHEMATICS and nonlinear systems^{1) – 2) – 3)}

According to R. MAY: “The elegant body of mathematical theory pertaining to **linear systems** (**Fourier analysis**, orthogonal functions, and so on) and its successful application to many fundamentally **linear** problems in the physical sciences, tends to dominate even moderately advanced University courses in mathematics and theoretical physics. The mathematical intuition so developed ill equips the student to confront the bizarre **behavior** exhibited by the simplest of discrete **nonlinear systems**... Yet, such **nonlinear systems** are surely the rule, not the exception, outside the physical sciences” (1976, p.467).

The trend to use linear mathematics in social sciences, for instance, has been a stumbling block for the use of systems concepts by sociologists and explains some of their sharp criticism. In J. MARTINO's words in his review of BERLINSKI's “On Systems Analysis”: “There is no proof offered by the **systems analysts** that social and political systems are at all similar to **control systems**” (1979, p.18).

MAY advocates the study of 1st order **nonlinear** difference equations, as a starting point. Since 1976, when he published this paper, a considerable body of new mathematics of **nonlinearity** has been created.

It should be emphasized however that the first important work on **nonlinearity** was POINCARÉ's 1889 paper on the **three bodies problem** and that POINCARÉ himself introduced various **topological concepts** that led to **chaos theory**.

→ Poincaré Section

2022

MATHEMATICS and Systemics³⁾

The mathematician Hermann WEYL wrote in 1928: “Occidental mathematics has in the past centuries broken away from the Greek view and followed a course which seems to have originated in India and which has been transmitted, with additions, to us by the Arabs: in it the concept of number appears as logically prior to the concepts of geometry. The result of this has been that we have applied this systematically developed number concept to all branches, ir-

respective of whether it is most appropriate for the particular application. But the present trend in mathematics is clearly in the direction of a return to the Greek standpoint...” (Quoted by W.H. HUGGINS – 1963, p.132).

This view proved to be prophetic.

W.H. HUGGINS observes that “traditional mathematics does not provide us with adequate denotations of the following kind of entities: **signals, patterns, operators** and, generally, scaled **sets** of physical observables *in space*” (p.133).

To the “science of magnitudes”, as A. BOGDANOV described mathematics (1980, p.46), a complementary science of static and dynamic **connexions** is now growing swiftly. It includes **graphs, groups, topology, sets** (common or fuzzy), **catastrophes, fractals, chaos, criticality**, and possibly more.

G. KLIR acknowledges this: “Mathematically derived **systems knowledge** is the subject of various mathematical systems theories, each applicable to some class of systems. It consists of theorems regarding issues such as controllability, **stability, state** equivalence, **information transmission, decomposition, homomorphism, self-organization, self-reproduction**, and many others” (1991, p.101).

From a systemic viewpoint, G. KLIR observes: “Mathematical theories are most frequently developed for assumptions that are interesting or convenient from the mathematical point of view. As a consequence, they produce **methods** that cover rather small and scattered parts of the whole spectrum of systems problems... Hence, the primacy of problems in **systems methodology** is in sharp contrast with the primacy of **methods** in applied mathematics” (1993, p.39).

As a result, only parts of classical mathematics are well adapted to systemics. However, various new developments of mathematics appeared during the 20th. century, independently or not from G.S.T. and **Cybernetics**, as well as some new theories, not purely mathematical, but with a strong mathematical basement, which are obviously useful for systems sciences and **methodology**.

In a sense, systemics adopts or even spawns a new type of *qualitative* mathematical theories.

Hereafter, a tentatively classified list of these theories.

1. Older mathematical and logical theories and concepts well adapted to systemics: (partly based on L.von BERTALANFFY's “Outline of a G.S.Theory”) (1962, p.134-165).

- Theory of **categories** (N. HARTMANN)
- Differential and integral calculus
- **Isomorphic** laws: the exponential law; the **logistic** law (VERHULST); the law of **allometric** growth (W. PARETO).
- Mathematical theory of **populations** (V. VOLTERRA – A. LOTKA)

- **Binary** logic (BOOLE)
 - Theory of **sets**
 - Theory of **graphs**
 - Theory of **nets**
 - Theory of **cyclical phenomena**
 - **Stability** theory (LIAPOUNOV)
 - 2. Mathematics of cybernetics
 - Theory of **communication** (C. SHANNON and W. WEAVER)
 - Theory of **feedback, oscillations** and **control** (N. WIENER)
 - Theory of **information** (C. SHANNON, L. BRILLOUIN, D. MACKAY and others)
 - 3. G.S. generated mathematics
 - Mathematical theory of systems (von BERTALANFFY)
 - **Systems dynamics** (J. FORRESTER)
 - Theory of **hierarchical multi-level systems** (M.D. MESAROVIC, D. MACKO & Y. TAKAHARA)
 - Arithmetic relators (groupe SYSTEMA France)
 - **Reconstructability theory** (G. KLIR)
 - 4. Independently created mathematical theories important for systemics
 - **Topology**
 - **Catastrophes** theory (R. THOM -E.C. ZEEMAN)
 - **Fuzzy sets** theory (L. ZADEH)
 - **Fractals** (B. MANDELBROT)
 - **Theory of games** (J.von NEUMANN)
 - Theory of **algorithms**
 - Theory of **recursivity** (G. SPENCER BROWN)
 - **Deterministic chaos** (LORENZ, SMALE, RUELLE, etc.)
 - 5. Systemic mathematical theories originated in some specific sciences
 - Theory of **dissipative structures** and **bifurcations** in **non-equilibrium systems** (I. PRIGOGINE)
 - **Synergetics** (H. HAKEN)
 - Theory of **hypercycles** (M. EIGEN & P. SCHUSTER)
- G. KLIR emphasizes “the current trend of generalizing mathematical theories...” and gives the following examples:
- “from quantitative theories to *qualitative theories*;
- from **functions** to *relations*;
 - from **graphs** to *hypergraphs*;
 - from ordinary geometry (Euclidean as well as non-Euclidean) to *fractal geometry*;
 - from ordinary **automata** to *dynamic cellular automata*;
 - from linear theories to *nonlinear theories*;
 - from regularities to singularities (*catastrophe theory*);
 - from precise analysis to *internal analysis*;
 - from classical measure theory to *fuzzy measure theory*;
 - from classical **set** theory and logic to *fuzzy set theory and logic*;
 - from regular **languages** to *developmental languages*;

- from intolerance to inconsistencies of all kinds to the *logic of inconsistencies*;
 - from simple **objective** criteria **optimization** to *multiple objective criteria optimization*" (1993, p.52-3).

6. Other models and formulations

- attractors of distinct types
- games of life (J. CONWAY)
 (in fact: cellular automata)
- Markov Chains and Matrixes
- Markovian systems
- Matrixes
- Networks
- Percolation
- Power laws
- Renormalization
- Scaling laws
 (these last three closely related)
- Solitons
- Tilings
 (In most cases, see corresponding article)

2023

MATHEMATICS (Polysemy in)²⁾³⁾

In his book "Facts of Science", V.V. NALIMOV observes that polysemy has now also appeared in the **language** of mathematics (1981b, p. 75)⁴⁾. He writes that, from **Gödel's theorem** "it follows that human thinking is richer than its deductive formulation" (Ibid)

This new mathematical polysemy resulted (quite recently) of the use of mathematics "for describing poorly organized, diffuse systems... (as) the requirements placed on mathematical **descriptions** have become less strict. Whereas the description of real phenomena in mathematical language was earlier regarded as the expression of a **law** of nature, now it has become possible to speak of mathematical **models** which may all simultaneously be legitimate" (Ibid)

Nalimov adds, further on, that "this **polymorphism** of the language of applied mathematics increases its **flexibility**" (Ibid)

However he feels clearly some qualms about this evolution. He escapes more or less from these by defining mathematical models "as a question to Nature asked by a Researcher"

"Matters like **computer modelling** technique or **fuzzy algorithms**- of enormous practical usefulness are surely pertaining to this type of "questions asked". Are mathematics turning from **deductive** to **inductive**...and even possibly **abductive**?

2024

MATRIX²⁾

"A table of columns and rows employed for organizing a **set** of interrelated values."

A matrix is basically a combinatory device. It can be used, for instance, to discover all the possible **interconnections** between various characteristics; or indicate all the possible

transitions from one **state** or **phase** to others, indicating its various probabilities. It may also be constructed and operated as an **encoding-decoding** device.

J. WARFIELD and N.M. AYIKU proposed the use of a number of interconnected **binary** matrixes to understand complex **flows** of any kinds within a system. They emphasize the following types of matrixes:

Input matrix: to be used to define what **inputs** are required by each actor

Output matrix: to be used to find out what **outputs** are produced by each actor

Actor interaction matrix: to respond to the structural question: what actors supply **inputs** to what other actors

Input-Output matrix: responding to the structural question: What **inputs** are required to produce what **outputs**.

It may be useful to convert these matrixes into **graphs**, which may lead to an "**interpretive structural model**" (J. N. WARFIELD & N.M.B. AYIKU, 1989, p.29-35).

→ J. WARFIELD for a very complete survey of the subject of matrixes use in systemics (p.220-63).

Matrixes are generally two-dimensional, but may have more dimensions. This however makes their practical use much more difficult.

→ **Markovian matrix**

2025

MATRIX BUILDER^{2) - 3)}

A general **heuristic** tool to be used to discover significant **interconnections** in the whole systemic field.

This was a L. TRONCALE proposal during the fourth FUSCHL conversations (1985, p.73). Its present status is unfortunately uncertain.

According to TRONCALE: "This tool would aid a user in identifying key **parameters** of a problem using general **morphology**, then use these to build several axes which describe a multidimensional **space**. Each axis would represent a distinct and separate, but critically important approach to the problem under study. Comparison between the axes would create many multidimensional **intersect spaces**... Each... would contain **information** on how the various **categories** of the various **taxonomies** of **parameters** (represented by all axes) interact with each other. In this way, each particular of each **taxonomy** should be systematically compared with each particular of the other **categories** and **taxonomies**. Each **connection** specified in an intersect would be explained in **semantic** terms, linked to literature or **data**, and... would serve as a point of departure for **tracing** to other **connections**. This tool would combine features of **expert systems**, relational **data** bases, and some unique, new capabilities into a user-oriented tool".

In synthesis, the matrix builder could become a meta-**taxonomic** tool.

The present work may somehow be considered as a not-formalized and quite partial version in colloquial English of a matrix builder.

2026

MATRIXES and GRAPHS²⁾

S. LIPSCHUTZ writes: "It is sometimes practical, especially for computational reasons, to represent (a graph) G by a matrix. Note that the **edges** of G can be represented by an $n \times 2$ integer matrix B where each row of B denotes an **edge** of G... This *edge matrix* B does not completely describe G unless we are also given the number m of vertices (**nodes**) of G..." and: "...the adjacency matrix is very useful in deciding questions of **connectivity**" (1976, p.88).

Conversely, it may be useful to represent a matrix by a graph.

→ **Graphs**

2027

MATRIX (The)¹⁾³⁾⁴⁾

L.H. KAUFFMAN writes that this film "is a cinematic exercise in virtual reality and virtual logic" (1999, p. 65)

It could also be said that it is an animated **metaphor** of probably quite basic characteristics of human societies. Kauffman describes it as follows: The Matrix is all around you. It is in the air you breathe, in the ground you walk on, in the sights you see and in the feelings that you feel. You yourself are composed of it just as much as it is composed of you" (Ibid)...and of course, of all humans.

"You imagine yourself to be an **observer** independent of the Matrix, but the very possibility of your **observation**, your sense of **Self** and World is produced by the Matrix.

"One might say that the Matrix observes itself, but that would be overstepping the bounds of **language**, for the very act of saying that "it" observes "itself" presupposes a split between the observed and the observer that does not exist in the presence of the act" (Ibid)

Kauffman's short paper develops striking comments. In its own way, it is reminiscent of the "Public opinion" engraving of Arnold BÖCKLIN.

One may also ask oneself if the Matrix metaphor could be a significant step toward the deeper **understanding** of ourselves, that all humans need urgently if we are to avoid the global demise of the species.

→ **Contingency (Mutual); Cultures as systems; Language and culture; Metaphor; Parallel distributed processing; "Reality" (Riddle of); Stigmergy; Swarm intelligence**

2028

MATTER^{1) - 3)}

Anything that can be perceived as occupying some **space** during some **time**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The true nature of matter seems to become evermore elusive in modern science. EINSTEIN's understanding that particulate matter could be the result of local and instantaneous **energy** concentrations in a fundamentally continuous **field** is becoming more and more confirmed.

H. SABELLI and L. CARLSON-SABELLI formulate that idea as an hypothesis: "**Structures** of matter are formed when opposite forces in a system are both of high and similar intensity... At the most fundamental **level**, **energy** forms matter, which is an **equilibrium** or **symmetry** between opposing **energies**" (1992, p. 663).

D. BOHM and F.D. PEAT go farther and write: "Current quantum **field** theory implies that what appears to be empty **space** contains an immense "zero point **energy**", coming from all the quantum **fields** that are contained in this **space**. Matter is then a relatively small **wave** or **disturbance** on top of this "ocean" of **energy**" (1987, p.199).

As stated by A. KORZYBSKI, there can be no matter outside **space** and **time** and the equivalence and convertibility of **energy** into matter and conversely, also proposed by EINSTEIN, has been dramatically confirmed by nuclear fission.

The possibility that matter appears as the materialization of **vortexes** in interacting **fields** has also been studied by the French engineer Ch. LAVILLE (1950)... and obviously already sensed by d'ARCY W. THOMPSON in his famous work on "Growth and Form" (1916).

Matter is somehow related to **information**. L. CARLSON-SABELLI and H. SABELLI state: "**Energy**, matter and **structure** coexist as three distinct inseparable aspects of **action**. Even the simplest subatomic particles have material and energetic aspects (quantum wave, particle duality) and contain **information**, albeit limited (quantum **uncertainty**)" (Ibid).

To conclude, so-called "matter" could be a fragmented perceptive and conceptual interpretation of an integrated reality whose true nature remains elusive.

2029

MATTER-ENERGY STORAGE²

→ **Storage (Matter-energy)**

2030

MATTER-TIME¹⁾

The astrophysicist J.A. WHEELER, as quoted by H.C.von BAYER (2001, p. 16) wrote: "**Matter** tells space-time how to curve, and **space-time** tells matter how to move"

2031

MAXIMIZATION and ORGANIZATION^{1) - 4)}

The principle of global **energy flow** maximization proposed by LOTKA (see hereafter) implies a more or less hidden condition: the minimiza-

tion of **dissipation** rates in the participating systems, which constitute an interconnected **net of energy** using **organisms**.

The **optimum** then corresponds to a **situation** in which the global system maximizes the **energy flow**, but inversely minimizes its general **dissipation rate**. This corresponds to the maximum **variety** in the global system and to *efficiently optimal use of energy*.

Accordingly, R.N. ADAMS enounced the principle in quite a different way: "The distinctiveness and **stability** of the **boundaries** of a **dissipative process** vary directly with the tendency of that **process** to seek a minimum **dissipation rate** and inversely with its tendency to maximize **energy flux**" (1988, p.149).

ADAMS applies the principle to **social systems** and states some interesting points:

"The **dissipative process** sets its own energetic **boundaries**" and,

"Similarly, when the amount of **energy** available to a social assemblage is limited, the **dissipation** of that **energy** will lead to more rigid definition of the **boundaries** of the assemblage, to its evolving increasingly closed **self-organization**". Consequently: "Thus limiting **energy flow** is **self-organizing**. **Energetic boundaries** become clearly evident when efforts are made to conserve the **energy** available, because this requires reducing external **dissipation**" (Ibid).

The principle is clearly related to the construction of complex social **organization** in **ecosystems**, animal societies and **human systems** where the **heterogeneous variety** is put to the best use. Social **complexity** in turn, is an **emergent process**. This connects the whole subject to the **far away from equilibrium dissipation processes** considered by PRIGOGINE and his collaborators.

It opens very stimulating insights on the present **process** of planetary economic, social and political **integration**.

2032

MAXIMIZATION PRINCIPLE (LOTKA)^{1) - 4)}

"In every instance considered, natural selection will so operate as to increase the total **flux** through the system, so long as there is presented an unutilized residue of **matter** and available **energy**" (1922, p.148).

It is noteworthy that LOTKA himself seemingly never used the expression "Maximization Principle", which allows for dubious interpretations. (see below: "**Maximum power principle**").

In any **environment**, there is always room for a species able to utilize some free **energy**. The very important consequence – in particular for the human species – has been thus described by LOTKA, in 1924: "Such a species

will therefore, other things being equal, tend to grow in extent (numbers) and this **growth** will further increase the **flux** of **energy** through the system" (1956, p.357).

This is exactly what happened with our species, particularly since we learned to use fossil **energy**. Combined with **structuration through dissipation** as explained by PRIGOGINE, the Principle could be considered as the prime mover of all of human history.

In 1945, LOTKA added a caveat that nobody seriously heeded, even if it could very well be the key to the *future* history of mankind: "The principle contains a reservation: a maximum compatible with the **constraints**" (1945, p.192).

In an **environment** globally exploited, the decisive **constraint** could be the massive **accumulation** of non-recycled **waste**, particularly thermal **waste**.

We are unaware of **Gaia's constraints** or choose to ignore them. This could have portentous consequences.

2033

MAXIMIZATION vs. OPTIMIZATION¹⁾

In the **linear** perspective, optimization is frequently confused with maximization. This problem arises from the belief that some **function**, supposedly independent of **context** (the famous mental jingle "... *et ceteris paribus*") can be (and should be) maximized. However, in **complex systems**, which are always **nonlinear**, true optimization requires the best possible reciprocal harmonization of the different **functions** of the system, which can be obtained only through a repeated balancing act within the global **network**.

2034

MAXIMUM POWER PRINCIPLE²⁾

"Systems which use energy best, survive" (H. & E. ODUM, 1976, p.39).

As enounced under this form in 1976 by H. and E. ODUM, this principle is different from LOTKA's one and seems somewhat over-simplified.

LOTKA seems to refer himself to complex **ecosystems** (The "**world engine**" being the most global one), but not to separated individual species.

H. ODUM himself recognized in 1983 that: "According to LOTKA's maximum power principle, systems tend to develop **designs** that maximize power and thus may be expected to develop loadings less than efficient" (1983, p.116, quoted by R.N. ADAMS). This author observes: "There is nothing in LOTKA's principle that implies that systems "tend to develop ... maximum power". Indeed, LOTKA asserts that whether higher **energy**-using forms emerge is "determined by other principles" (ADAMS, 1988, p.38-39).

→ **Saint Matthew's Principle**

2035

MAXWELL's DEMON²⁾

An imaginary being endowed with sufficiently keen **perceptions** to be able to reverse **entropic disorder** in an **isolated system** by **controlling** in a **selective** way the movements of its **elements**.

Such a being would be capable by its action to violate the **second law of thermodynamics**.

However, as stated by A. RAPOPORT: "MAXWELL's argument... contains a basic fallacy. If the demon is placed inside the system, the **processes** going on within him must also be taken in account in computing the total **change** in **entropy**. It was subsequently shown by L. SZILARD (1929) and later by L. BRILLOUIN that the **processes** within the demon (whether he is a **mechanism** or an **organism**) must be such that the decrease in **entropy** effected by his intervention is at least compensated (in general, over-compensated) by an increase of **entropy** in the demon. If, on the other hand, the demon intervenes from outside the system, then the system can no longer be considered to be **isolated**, and the **Second Law** does not apply" (1966, p.7).

The point can also be made by observing that the demon must acquire **information** through an observational **process** that is not gratuitous in **energy** terms and, moreover, needs **energy** in order to move the **elements** in an ordering way.

2036

MEANING^{3) - 4)}

"The set of **functional** properties of the **response** produced by a **stimulus**" (after R.L. ACKOFF and F.E. EMERY, 1972, p.170).

These authors emphasize that "... a **sign** may have different meanings for different individuals, or different meanings for the same individual at different times" (Ibid)

Quoting C. CHERRY, they add: "A meaning is not a **label** tied around the neck of a spoken word or phrase. It is more like the beauty of a complexion, which lies altogether 'in the eyes of the beholder' (but changes with the light!)" (p.171).

J.Z. YOUNG expresses a similar opinion: "A **sign** has meaning when a **group** of people has adopted a particular **program** for using it. Hence the meaning of a word is defined by the **rules** for its use and the circumstances under which it can be verified" (1974, p.295). In short, meanings are, by necessity, **accepted** meanings (G. WEINBERG, 1975, p.56).

Meaning is a many-sided concern. Different views may be more complementary than opposed.

For K. SAYRE, meanings "... are neural **patterns** removed from exclusive **control** by external **objects**, and brought under the **control** of verbal **signals**" (1976, p.210).

While it remains to be better understood how verbal **signals** systems become organized by individual **brains** (**autogenesis of language**), this is a bridge between so-called "objective" and "subjective" concepts of meaning. From another viewpoint, **languages** become useful only when they are usable between individuals who have a **similar control** of verbal **signals**. There are thus at least two enmeshed **levels** in this **process**: the individual one and the collective one. However **similar control** is transmitted from generation to generation by training and teaching.

In E. SCHWARZ words, meaning is hetero-referential, emerging from **interrelations** (1992, p.757). It must be acquired by **learning**, **adaptation** and **accommodation** in individual minds, through a very complex cerebral **process**, still poorly understood. **Signals** carry meaning only for pre-structured minds, but minds become pre-structured by previous interpretation and absorption of formerly non-significant **signals**. Such a **process** would be impossible outside of complex social and cultural settings. We receive our interpretations from people who already possess them and, to acquire these significances, *we must accept them*. Only later on, may we in some cases revise and correct them.

We use these interpretations, acquired by **learning**, to observe the world around us, which implies that they constitute a **frame of constraints**, i.e. a **frame of reference**: Shortly, there is a **socio-cultural matrix** of accepted meanings.

Of course, as stated by D. Mac KAY: "Questions of meaning need not arise until we bring in the human links in the chain..."

"The original speaker, we suppose, means something by what he says. His utterance has meaning, at least for him. Yet, in the next stages of the chain... (the generation of sound waves and all the rest of it) all **signs** of his meaning seem to have disappeared... Yet, finally, when the **message** reaches the ear of a human listener, its "meaning" seems to pop up again from nowhere." (Mac KAY, 1969, p.20).

Such a **process** evokes awkward questions and still more so that the meaning does still not reappear into the ear, as the **input** must be processed by the **brain** in ways up to now poorly understood.

Another curious aspect is that, without an appropriate **receiver**, any meaning is lost. In Mac KAY words: "Meaning is always meaning *to someone*" (1969, p.36).

When the **message** reaches a **receiver** apt to give it a meaning, this acts like a selective **function** and may trigger a specific **behavior**.

As observed by P.Y. RACCAH, meaning can be considered as a set of instructions to the **receiver**, or imply **constraints** needed in order to make some sense out of the **message** transmitted (1993, p.1247).

2037

MEANING AND INFORMATION³⁾

J. S. WICKEN states: A "reader" brings implicit information to read which is read as part of the system information in which he/she participates- whether this be a theory or a poem. We don't know how to quantify this dimension of information. An **organism**, in an important sense, results from the **grammar** of its own generation: we don't know that **grammar** yet. Although we can understand **order** and **complexity** in crisp mathematical terms, "meaning" requires a transaction between knower and known whose terms are presently remote from our **understanding**" (1979, p.142).

What the "reader" introduces in the **process** of meaning formation depend on her/his cultural location, historically as well as geographically and his/her specialization. Moreover, everyone brings in his/her own "mindscape" (see MARUYAMA, 1966).

Meaning is mainly subservient to implicit **knowledge**, i.e. formerly acquired and organized information.

2038

MEANING (Imaginary)³⁾

A meaning does not necessarily reflects some (so-called) "**objective**" reality.

I. SEMETSKY observes that, for Ch. S. PEIRCE, the american founder of semiotics: "The **object** to which the **sign** refers may not have a solely physical existence but may as well be a thought, a dream, or an imaginary entity" (2001, p. 112)

A good example is the red cross. This sign was created by inverting the colors of the swiss flag and was then given a meaning: "medical help available". This meaning was progressively transmitted and accepted by more and more people.

It thus acquired the status of significant **symbol** and is now universally known.

But the meaning it conveys could as well have been represented by a green star with five spikes or by two intersecting circles (one red and one blue), or by a stylized heart, or any other easy to read.

This shows that any sign is a sign only through

- a) a psychic invention of an individual creator
- b) **conversational communication** among various individuals
- c) by **transmission** in the time dimension to new bearers

→ **Ideograms; Language (visual)**

2039

MEANING (Meaning of)³⁾

D. Mac KAY states: "A distinction should be carefully made between the notion of meaning to the **receiver**... and the notion of intended meaning (*by the transmitter*) and generally accepted meaning." (1969, p.72).

- Intended meaning is the meaning which the **transmitter** tries to convey to the **receiver** or receivers. It depends on the **level** and soundness of **knowledge** and intentions of the **transmitter**.
- Generally accepted meaning is that which is accepted by **consensus** by a majority of the concerned people (irrespective from its intrinsic factual **truth** or falsity, while it is generally presented as "**truth**").
- Meaning to the receiver is what the **receiver** understand from the **message** received as it evokes in him a complex **background** of former **reactions** and **knowledge**.

The **receivers** views may or not coincide 1) with the **transmitters** interpretation; 2) with the common **consensus** and the generally admitted "**truth**".

2040

MEANING OF A MESSAGE³⁾

"Its selective function on the **range** of the recipient's states of conditional readiness for **goal-directed activity**" (D. Mac KAY, 1969, p.24).

By "conditional readiness" Mac KAY understand the number of possible **states** of the **subject**, some of which may or may not be actualized by the message. He writes: "It is not until we consider the **range** of other **states**, that *might have been selected but were'nt*, that the notion of meaning comes into its own. A **change** in meaning (*in the message*) implies a different selection from the **range** of **states** of readiness" (Ibid).

In other words, the message is an activator of **behavior**, but then only within the **limits** of the possible **states** of the **subject**.

The concept is akin to:

1. VENDRYES' concepts of **autonomy** and subjective probability
2. MATURANA and VARELA's concept of **auto-poiesis**

It does not however clarify the mechanism of the acquisition of the "**range** of the recipient's (*possible*) **states** of conditional readiness".

In any case, Mac KAY concludes "... meaning is clearly a **relationship** between message and recipient rather than a unique property of the message alone" (Ibid.).

This is why the same message may very well convey different and even opposed meanings for different recipients.

2041

MEANING ORGANIZER¹⁾²⁾

The pedagogical use of some very general term or **concept** in order to create **correlations** among a number of different themes.

R. NUMMELA CAINE and M. CAINE give as an example the concept of "Family", used as a **mental frame**, or thematic **map**, to interrelate many quite different types of groupings: Families of humans (in psycho-sociology and anthropology); families of laws, or families of **elements** (in physics); animal or vegetal families (in natural sciences **taxonomies**); families of rulers, family trees (in history); families of planets or stars (in astronomy and astrophysics); etc... (1994, p.129).

Of course, such meaning organizers may not even reach the **analogies** or **metaphors levels** and should be used with care. They are not much more than mental catalyzers, useful to construct **mental maps**.

2042

MEANING SYSTEM^{3) - 4)}

The set of **values**, **norms**, **concepts**, **rules** and **models** proper to some **human group**.

F. ROBB states: "In the initial stages of the 'life' or an institution, intensive **conversation** plays a major role. This defines the kernel of the system of meanings and legitimates in the participants' **understanding** the taken-for-granted assumptions upon which the meaning system rests" (1993, p.2).

The meaning system stabilizes the **organization** or institution, because it gives it **cohesion**, avoids deviant **behavior**, spares efforts and **time**, limits the squandering of **resources** and, generally speaking, **regulates** the whole **activity** of the system.

In a much extended and **metaphoric** sense the genetic **code** could possibly be considered as the cellular meaning system. It would be very interesting to see if it is elaborated through some kind of cellular "**conversation**". And, of course, meaning systems are constructed in each individual **brain**: could it be through some kind of neural "**conversation**" about **percepts** (obtained from **conversation** with other people about **objects** and **concepts**?).

2043

MEANING THEORY¹⁾²⁾³⁾⁴⁾

K. BAUSCH resumes as follows J. HABERMAS views on meaning. "...it is based upon the **semiotic model** of a linguistic **sign** used by a speaker (sender) with the aim of coming to an **understanding** with a hearer (receiver) about **objects** and state of affairs. In such a semiotic model of communicative **actions**, meaning has three elements: the cognitive **representation** of a state of affairs; the expression of the expe-

riences of the speaker; and the direction of requests to addressees" (Glossary, pers. comm., 2002)

In fact, many other aspects are also critical for the construction and the **transmission** of meaning (see cross references hereafter)

→ **Brain**; **Code**; **Code creation**; **Cognition**; **Communication (Human)**; **Communication theory**; **Concept**; **Conversation**; **Frames of references**; **Information**; **Log-on**; **Meaning**; **Metron**; **Observer**; **Organization closure**; **Redundancy**; **Semantics**; **Semiotics**

2044

MEANINGLESSNESS³⁾

Character of a **message** which "lacks a selective **function**" (D. Mac KAY, 1969, p.25).

D. Mac KAY states: "We have to distinguish between meaninglessness due to:

- a) lack of definition of selective **functions** (e.g. non-sense syllables, or words, or sentences)
- b) absence of the appropriate **range** in recipient (e.g., colour to a blind man)
- c) incompatibility of two or more **components** of the selective **operator** (e.g., the milk is isocoles).

"Clearly, utterances can be partially meaningful (or meaningless) under the above heads" (p.129).

More specifically, the following example in **languages semantics** make these aspect clear:

a) "Amünkoni felpertna potarisko hapu" is a fancyful sentence without any meaning in any **language**. But the **receiver** can be reasonably sure of this only if I, as the **emissor**, tell him so and *if he supposes that he may believe me*. Curiously the above fancyful sentence could become a meaningful example of meaninglessness, i. e. acquire meaning.

b) "Mutoto alivunja sahani moyo" is a correct sentence with a precise meaning in Kiswahili (an East African language). It is meaningful for somebody who knows the **language** and meaningless for one who does not. This latter one is unable to perceive the difference between the imaginary and the genuine significant sentence.

c) "The milk is isocoles" is nonsense for both **emissor** and **receiver**, provided both do know English. However someone who does not, is unable to differentiate this sentence (senseless for him/her) from any other senseless utterance of types a) or b).

One could possibly add still a fourth case, when an old **language** is lost and is meaningless because there are no more **emissors** or **receivers** who are able to make sense of it.

2045

MEANINGS (Formation of)³⁾ - 4)

According to F. ROBB: "... commonly agreed meanings are formed, by negotiation or compulsion, between at least two conversants. The formation of meanings, in this context, is taken to include making **distinctions** between **objects** in experience (or in thought) and their ground, forming mental **models** and making valuations about **situations** and **objects**; so that 'good' is discriminated from 'bad', 'desirable' from 'undesirable', and 'true' from 'false'".

Moreover, "**Conversations** may also negotiate what constitute valid ways of making these **distinctions** and of establishing these values" (1993, p.1).

I. BEESON (1997), after considering HUSSELER's **phenomenology** and its critique by DERRIDA (1973), and MERLEAU-PONTY's **Phenomenology of perception** (1962) observes: "Our existence is shown as fundamentally intersubjective, but not as fundamentally rational. Meaning is nowhere constant or fixed, but in achieved by people working together to make sense of a world whose **boundaries** are constantly reforming. Such work always throws up meanings not prefigured by existing **understandings**". In short "**Rationality** is revealed as a superstructure"...and "...a rhetorical rather than a logical achievement"

Such a relativity looks suspectedly like quicksands and could easily lead to rational paralysis. It is however for sure necessary to remain careful about so-called meanings.

→ **Falsifiability; Filter; Ontological skepticism; Perception (Limits to)**

2046

MEANS-ENDS ANALYSIS²⁾

A **systems analysis** technique used to determine which **inputs** are necessary to obtain some pre-defined **outputs**.

W. LEONTIEFF's **input-output matrixes**, for instance, are tools for means-ends analysis. Of course, means-ends analysis is just that: it does not show whether it is useful or sensible to use such **inputs** in order to obtain such **outputs**. It does not give for example, any **information** about any kind of possible **side-effects**, as for instance unexpected **environmental** or social nocive outcomes, or financial problems.

2047

MEASUREMENT¹⁾ - 2)

1. "Any explicit move to obtain some quantitative **knowledge** of a system, or part or **process** of a system" (J.L. DESTOUCHES, 1990, p.479).
2. "The assignment of numerals (and numbers) to represent properties" (N.R. CAMPBELL, 1957, p.267).

(According to CAMPBELL, a numeral is a material or quasi-material **symbol**, while a number is a mathematical concept. While numbers can be added or multiplied, numerals cannot be).

Measurements can be obtained using some instrument or device, but also by organizing a statistical **inquiry** or even using a more approximate way of evaluation.

J.L. DESTOUCHES states: "Any measurement is imprecise. It implies the **interaction** during a certain **time** of the studied system and another specific one, the measurement device (endowed with some observable characteristic, which will have changed after the measurement). Thus, any measurement implies a whole **process** with complex **transmission** devices of the obtained **information** and for showing the results. This introduces limitations to the **knowledge** of the system. One may conceive that some measurements cannot be made simultaneously because both measurement instruments cannot be used at the same moment, as it is for example, the case in quantical physics".

"While any positive **knowledge** about a system must be obtained by measurement, any measurement presuppose a theoretical **concept**, or at least a **model**. This is a dialectical situation. The **model** includes constants, **parameters**, **variables**, and **relations** between these quantities. Measurements are to be of these quantities: if the **model** is adequate and reliable, the quantities correspond to properties of the **concrete system**...

"A measurement is a concrete **action**, which is not at the same **level** as the **model**, but at the **level** of the system, while on the contrary its interpretation is at the **level** of the **model**" (p.430).

DESTOUCHES adds: "... the word 'measurement' must be understood in a broad **meaning**, it denotes any manipulation and any explicitly formulated **method** designed in order to provide a positive empirical or experimental **knowledge** about the studied system... using as well an apparatus, a device, like a questionnaire, an inquest or a measure of samples, any **process** explicitly formulated, giving a **knowledge**, i.e. a result about the system" (1980, p.197).

D. GERNERT refined still more these views, insisting that: "A scientist decides *what* to measure (or to observe) and *how* to do it (decision phase)". The results must finally be interpreted by this initiator, who in most cases depends on devices and intermediaries (1994).

2048

MEASUREMENT SYSTEM²⁾

Set of concrete **elements**, organized in view of a measurement project and **method**, explicitly formulated and applicable to certain specific systems.

According to J.L. DESTOUCHES: "A **model** of this measurement system must be built, as well as a **model** of the measurement **process**, being it a physical, biological, or economical measurement" (1990, p.480).

The properties of the measurement system were stated by P. GONELLA (1976) and J.L. DESTOUCHES quotes them as follows: "A measurement device must produce a "measurement **signal**" shaped by the measurement **interaction**, which brings out some **information** about the measured **parameter**, and becomes elaborated by a chain of transducers, called measurement instruments, until it produces a "reading **signal**", received by the **observer** (which may be even another instrument).

"A **distinction** must be made between lecture (a **description** of the **output signal**) and the measurement (a **description** of the **signal** measured at the entry of the measurement device), which is expressed by a **set** of numbers related to the measurement unit. This is the "calibration relation" of the instrument which provides the **relation** between lecture and measure." (1990, p.480).

Thus, it is clear that any measurement is based on some preconception, depends of the characteristics of the instrument used, is generally registered in accordance with the perceptive capacity of the **receiver** and, finally, is interpreted in function of the **observer's model**.

Two more steps have entered the **process** under the form of computer **data** processing, which implies the sometimes hazardous translation of measurement **data** into a **data** system fit for computer use... and the final retranslation of the results.

2049

MEASURER²⁾

That **part** of a **regulator** which meets the **inputs** and **outputs** affecting the **process** or **function**.

The obtained **data** are needed to allow the comparing device, or **comparator**, to register **divergences** and, eventually, transmit these to the **effector**, for correction.

2050

MECHANICISM in CYBERNETICS¹⁾ - 3)

According to J.L. LE MOIGNE, the cybernetic **paradigm** may be considered "as an extreme form of the mecanicist **paradigm**" (1990, p.33).

This is in fact mainly the case of the **first cybernetics** as it was proposed and explained by N. WIENER who, as a practically oriented mathematician, insisted on the "**control** and **communication** in the animal and the **machine**".

It is indeed obvious that these first cybernetic **models** maintained a quite **reductionist** bias and were mainly applied to **stabilization** problems by introduction of strictly limitative **constraints**. It was mainly by the use of **negative feedback** that these were introduced, even if only a convenient sequence of **negative** and **positive feedbacks** is apt to produce a permanent **regulation**.

This initial cybernetic mechanicism made cybernetics quite suspect to psychologists and sociologists, who feared its possible use to justify or even organize some "Big Brother" type of social and individual **control**.

These qualms unfortunately closed their minds to M. MARUYAMA's **2nd Cybernetics** (**processes** of deviation and amplification by **mutual causality**) and still more so to the **cybernetics of 2nd order** of H von FOERSTER, related to **self-organizing systems**, and to the **conversation** concepts of G. PASK.

2051

MECHANISM ¹⁾

Any constructed device that can contribute to the **operation** of a **machine**.

To be reliable, a mechanism needs to present a foreseeable **behavior**. This supposes that it should be in principle entirely **deterministic**. This is for instance implied in classical celestial mechanics, as well as in the **operation** of any constructed appliance.

However, real mechanical devices are in the habit of breaking down because it is impossible in practice to endow them with rigorous **determinism** in front of unavoidable imperfections of their **elements** and unforeseeable **variations** in the conditions of their **operation**. This is also the case of purely mechanistic **models**, of which the theory of **deterministic chaos** shows the somewhat narrow limitations.

Mechanisms – either **models** of **machines** – are constructed by people, i.e. not self-constructed.

Even when quite complex, a mechanism can never be completely **autonomous**. It must be maintained and repaired by human experts. It is not **autopoietic**, i.e. it cannot reproduce its own **elements**, nor organize them in a **self-referent network**. The gap between machines and natural systems seems however to be narrowing (G.M. WHITESIDES, 1995, p.114-18), and foresaid may become less true in the future.

"Mechanism" is also frequently used in an **analogic** or **metaphoric** sense: the "mechanisms of economy", the "mechanisms of mind", etc... This is objectionable, because it introduces a conceptual bias into research and **models**.

2052

MECHANISM (Step) ²⁾

"A mechanism showing a **step function** as its main characteristic" (W.R. ASHBY, 1960, p.91).

This term was suggested to ASHBY by J.C. WISDOM.

Systems endowed with a step mechanism are able to switch their **behavior** from one **field** of **activity** to another one. ASHBY explain this in the following way: "Suppose, in a **state-determined** system, that some of the **variables** are due to step-mechanisms, and that these are ignored while the remainder (the main **variables**) are observed on many occasions by having their **field** constructed. Then, so long as no step-mechanism changes **value** during the construction, the main **variables** will be found to form a **state-determined** system, and to have a definite **field**. But on different occasions different fields may appear" (p.94-5).

Ashby adds:

"If the system had contained two step-mechanism, each of two **values**, there would have been four **fields** of the main **variables**. In general, n steps-mechanism, each of two **values**, will give 2^n **fields**. A moderate number of step-mechanism may thus give a very much larger number of **fields**" (p.95).

So, step-mechanism in systems explain how they remain **stable** ("ultrastable" in ASHBY's vocabulary) in a wide general **deterministic** sense, while however being able to adapt to a considerable **range** of variations, many times in a *seemingly random* way. Step-mechanism seem to open the way to **heterogeneity** and **complexity**.

For **changes** of field in an **ultrastable system** by **switching** at critical **states** through step-mechanisms, see ASHBY, 1960, p.96; figure 7/23/1.

2053

MECHANISTIC PARADIGM ³⁾

According to H.von FOERSTER and G. PASK, neither the **organism**, nor the **environment** can be identified with classical **automata** because, in this case neither can undergo any **change**. In such an **algorithmic** straight jacket, **adaptation** and **evolution** would be utterly impossible, as all possible **interactions** would have to be *strictly* predetermined.

The mechanistic paradigm produced mechanistic **models**, strictly **deterministic**, which could only "read" in nature very simple **causes** to **effects relations**. These **models** pervaded much of the conceptual outlook in **living** and in **human systems**, at least until 1960, and are still in some cases blocking a better **understanding** of truly **complex systems**.

The **thermodynamics of irreversible systems faraway from equilibrium**, the **catastrophe theory** and the **theory of chaos** seem to suggest that non-rigorously predetermined innovation remains always possible, even within the **frame** of **algorithms** formerly constructed by previous **evolution** and **learning**.

2054

MECHANIZATION ²⁾

"The **process** whereby the system makes the **transition** from the **state** of **wholeness** to the **state** of **summativity**." (I.V. BLAUBERG, V.N. SADOVSKY & E.G. YUDIN, 1977, p.55).

These authors state: "**Interaction** coefficients for each **element** of the system decrease and for $t \rightarrow \infty$ y tend to zero" (Ibid).

This implies that the system ceases to exist as such, being reduced to a number of unconnected **elements** (see the critique of the concept of **summativity**).

The term "mechanization" does not seem quite appropriate. Machines, even artificial ones, are made of more or less connected **elements**, which is how they become functional.

BERTALANFFY used the concept of mechanization, applied to systems, in a more satisfactory way.

2055

MECHANIZATION (Excessive) ^{1) - 4)}

D. KATZ and R.L. KAHN made the following comments (on human **organizations**, but of general interest for any strongly **integrated system**): "The typical **models** in organizational theorizing concentrate upon principles of internal functioning as if these problems were independent of **changes** in the **environment**..." (1966, p.100).

Such a limitation could also result of a too restrictive interpretation of the more recent concept of **organizational closure**.

The same authors add: "Moves toward tighter **integration** and **coordination** are made to insure **stability**, when **flexibility** may be the more important requirement. Moreover, **coordination** and **control** become ends in themselves rather than **means** to an end" (p.101).

These last comments are obviously relative to human **organizations**. It is however noteworthy that this tendency toward **rigidity**, here a result of a voluntarism unconscious of its own nature, can altogether be observed in **biological ageing** and in psychological disorders. It is possibly a result of **variety** exhaustion due to **constraints** increase resulting from continued readaptations to environmental **variations** and, more deeply to the unavoidable final entropization of any system.

2056

MECHANIZATION (Progressive)^{1) - 2)}

A **process** by which a system, at first governed by dynamic **interactions** of its **components**, acquires defined **structures** and **steady-state functions**.

This concept has been proposed by L.von BERTALANFFY as a general principle of **organization** (see "**Organization** as progressive mechanization").

D. KATZ and R.L. KAHN state this idea in the following way: "*early growth* is a **process** which involves an **interaction** of various dynamic forces, whereas the latter development entails the use of a regulating **feedback mechanism**" (1966, p.99).

In other words, the original "organizational dynamism" of the system, starting from its **auto-genesis**, is the motor of its **morphogenesis** and exhausts itself when the system matures.

2057

MEDIA^{1) - 4)}

"A generic term for systems of production and dissemination of **information** and entertainment".

Media, formerly limited to printed material, underwent a massive development during the 20th Century.

They are characterized by the possibility offered to individual senders – who anyhow are generally mere spokeswomen or men for some known or unknown **deciders** – to reach thousands or millions of **receivers**. Moreover, the **transmission of messages** is unilateral and can easily and artfully be used to condition the **receivers**, who have very scant practical possibilities of critical **feedback**. A result, as observed by K. KRIPPENDORFF, author of the definition, media are widely used to exert "various kinds of social **control**" (1986, p.48).

2058

MEDIATION^{1) - 4)}

The **activity** of a device or **subsystem** that connects and organizes the production of selected **subnets** in a certain way and according to certain specific needs.

A. and H. DAMASIO introduce what they call "mediation systems" as intermediates "... between the **brain's** concept-**processing** systems and those that generate words and sentences" (1992, p.70).

They show that **perturbations** in this **mechanism** explain many "neural brokerage" impairments as, for example, the impossibility to connect a person's face with her name.

The mediation **concept** seems to be a rediscovery of J. G. MILLER's **associator subsystem**.

Mediation **subsystems** do also probably exist in insect societies and certainly in human ones, where numerous **coordination groups** and devices of the most varied kinds can be recognized.

They probably will become a necessity in decentralized **artificial intelligence** systems, in which coordinated **interactions** are a very basic need.

2059

MEDIUM¹⁾

A region in **space-time** endowed with relative permanence where observable **events** take place.

"Observable" **events** are such for **living systems** endowed with *specific* capacity of **perception**. As observed by J.J. GIBSON, each medium induces a defined potential specifically adapted to possible **behavior** for a specific **living system**.

See: "**Affordance**".

Water induces specific **behavior** in a fish, and different ones in a swimming terrestrial mammal, or in a marine bird, like a penguin. And air induces a type of **behavior** in a flying bird, another in a butterfly, and another still in an aircraft's pilot. (1986, p.16-19).

A medium should be distinguished from an **environment**, which already implies a clear partition between some system and the non-system which whom it interrelates: such **environment** does not necessarily includes the whole medium.

Besides, as noted by E. MORIN: "The medium is not a stable setting, but a region where **events** surge" (1972, p.9).

A dynamically structured medium would be a **field** (see Ch. LAVILLE describing biological mechanisms considered from the atom to the living systems, 1950).

2060

MEMBERSHIP FUNCTION

→ Fuzzy sets (Theory of)

2061

MEMBRANE^{2) - 5)}

A thin film of chemical or biological **matter** that constitutes the specifically permeable **boundary** between a system and its **environment**.

Membranes are **interfaces** which selectively in **space** and **time** allow or inhibit the transference of **inputs** and **outputs** from the **environment** to the system and vice-versa. Membranes are as much connective devices as **separators**.

Some cosmologists and physicists recently started to use the strange neologism "brane" (= shortshrift for membrane) to signify the hypothetical divisions in-between the numerous dimensions now postulated in some theories about the **universe** (or universes)

2062

MEME^{1) - 4)}

"A unit of imitation" (R. DAWKINS, 1978, p.206).

DAWKINS introduces this neologism as a specific kind of **replicator** in human culture, "... a noun that conveys the idea of a unit of cultural transmission" (Ibid). The term should have been "mimeme" (as in mimic), but DAWKINS wanted "... a monosyllable that sounds a bit like gene" (Ibid)

"Examples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pots or building arches. Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so meme propagate themselves in the meme pool by leaping from **brain** to **brain** via a **process** which, in the broad sense, can be called imitation" (Ibid). N.K. HUMPHREY, a colleague of DAWKINS, summed all this up in this way: "... When you plant a fertile meme in my mind you literally parasitize my **brain**, turning it into a vehicle for the meme's propagation in just the way that a virus may parasitize the genetic **mechanism** of a host cell" (Ibid, p.207). Some kind of covert brainwashing!

J.T. BONNER observes: "The thing that sets memes apart is that they are learned by one individual from another, and they are not present in the DNA of the genes. Therefore, if an animal is removed from its mother before birth and raised in the absence of any of its own kind, it will lack all the memes that its family might have passed on, while it will retain all the genes that its parents bestowed upon it" (1988, p.209). So-called wolfchildren are a good example (J.A. SINGH and R.M. ZINGG, 1942).

A culture is characterized by a particular **population** of memes: a meme pool.

C.J. LUMSDEN and E.O. WILSON (1981) proposed the equivalent term of "mentifacts" and C.P. SWANSON (1983) the term "sociogenes" (quoted by G.R. JOHNSON, 1992).

According to S. BLACKMORE a full fledged meme implies more than simple copying some **behavior** or concept. Three additional criteria should be needed:

- The **message** must be accurately copied
- Many copies must be made
- The copies must last a long time" (L.A. DUGATKIN, 2000, p.55).

BLACKMORE gives the following list of memes and complexes of memes (2000, p.54):

MEMES	COMPLEXES OF MEMES
"Stories, urban legends, myths	Beliefs in UFOs, ghosts, Santa Claus
Clothing, hair styles, body piercing	Racist slogans, sexist jokes
Cuisine, cigarette smoking	Religions
Applauding, cheering	Inventions, theories, science
Languages, accents, catch phrases	Judicial systems, democracy
Songs, music, dances	Proust's story of the madeleine cake"

2063

MEME COMPLEX^{1) - 4)}

"A co-adapted stable **set** of mutually -assisting memes" (R. DAWKINS, 1978, p.212).

Memes complexes are created by **consensus** about the **significance** given to some **signs** and start being transmitted after such recognition. It is in this sense that G.R. JOHNSON may write that "...**information** exchange is really nothing more than a **metaphor** for biological **action** at a distance, i.e., the influence of one nervous system on other nervous systems through the production of physicochemical **stimuli** to which those other nervous systems are sensitive" (1992, p.1143). Or "A speaker says something that is a product of prior genotype-**environment interactions** and his or her current **environment**. A listener exposed to this **behavior** responds on the basis of his or her prior genotype-**environment interactions** and current **environment**" (p.1145).

DAWKINS states that we could perhaps regard as an example "... an organized church, with its architecture, rituals, laws, music, art, and written tradition" (ibid).

Meme complexes have obviously a strong tendency to propagate in **space** and a great survival power in **time**.

→ **Frame of reference**

2064

MEMEPLEX¹⁾⁴⁾

An interconnected **set** of **memes**. (a neologism)

Co-adapted **memes** complexes "include **languages**, religions, scientific theories, political ideologies and **belief** systems such as acupuncture or astrology. Like **memes**, memeplexes spread as long as there is some reason for them to be copied. Some are true or useful, other are copied despite being false" (S. BLACKMORE, 1999, p.44).

The memeplex is a kind of general **model** for widely shared and transmitted **knowledge** or beliefs in societies.

Remains to be seen how it can be connected with some physical **communication** means, as for example **integrate and fire mechanisms** that could take place between human **brains**.

2065

MEMETICS¹⁾⁴⁾

The study of the way **memes** translate from one individual to others, and of their effects.

R. DAWKINS, who introduced the concept of memes, and Susan BLACKMORE are the main promoters of memetics, which appears to be on its way to become a new discipline. It seeks to investigate the ways memes appear, become accepted and spread after the crossing of a critical **threshold**. (M. GLADWELL, 2000).

As such, it seems to point toward a deep reworking of some of our psychological and sociological **concepts** and **models**. It is obvious for example that religious **beliefs**, or **ideologies**, rumors and even fashions and fads do propagate in ways similar to **epidemics**.

According to a recent article by Susan BLACKMORE (1999, p.40-44), it could also lead to new insights about the deeper **meaning** of Buddhist psychology.

Memetics seems as well related to the "**mindbugs**" described by J. WARFIELD.

They are originally at least in part a biological metaphor, which could of course be in time elevated to the level of a workable analogy, leading to useful conceptual isomorphisms.

→ **Clanthink; Effects (Herd); Network; Percolation; Propagule; Runaway process; Small world**

2066

MEMORY²⁾

"The **subsystem** which carries out the second stage of the **learning process**, storing **information** in the system for different **periods of time**, and retrieves it".

This is one of J. MILLER's **20 critical subsystems** in **living systems** (1978, p.3). It does for **information** what the **matter-energy storage subsystem** does with **matter** and/or **energy**.

2067

MEMORY AND NOISE^{1) - 2)}

Memory is able to built itself (in whatever form) only by orderly integrating **noises** into already existing informed sequences.

In this way, there is an increase of **information** in the system... But the price that must paid for it is a decrease of **redundancy**, i.e. **serves** of internal unused potential **states** usable to counteract external **variety** introduced by **noise**.

Thus, memory as a **process** uses up its potential as it enrich itself.

This understanding of memory as an accumulative, but self limiting **process** of **organization**, is significant for biological as well as **socio-cultural systems** limited **survival**.

2068

MEMORY (Associative)²⁾

The capacity of various **elements** or **subnets** in a **network** to collectively retrieve and share **data** existing in the **network**.

In a quite close sense, M. BODEN speaks of "**contextual** memory", through which: "an **input pattern** can activate not only a similar **pattern**, but also some aspects of its previous **context**... An apple in a religious painting may remind you of Eve, whereas an apple in a still-life does not)" (1990, p.119).

It becomes evermore obvious that associative memory is the potential ability which enables the living **brain** to easily assemble existing **data** into very complex **representations** and perform quite difficult chores in very short spans of time. Associative memory seems to be preexistent to its uses, in the form of **frames of reference**, which express specific aspects of **organizational closure**.

Parallel distributed processing in **connection machines** (connectionist architectures) is now trying to emulate this ability.

2069

MEMORY (Computer)^{3) - 5)}

The often used analogy of computers memory with memory as a **function** of the **brain** is very misleading, as strongly emphasized by H.von FOERSTER in many of his papers (1981).

This author pointed out that, "Unfortunately, some anthropomorphically inclined quipsters have dubbed the **storage** system "memory", and henceforth, some naive psychologists – and, alas, some neurophysiologists – who believed the engineers to know what they were talking about, kept looking for **analogues** of magnetic tapes, discs, cores and drums within the nervous system" (Quoted by K.L. WILSON, 1979, p.31).

This is of course a quite demonstrative example of abuse of **metaphor** and even unwarranted **analogy**.

A computer's so-called "memory" is in effect a **data storage device**, which contains records, "... also the name properly given... in the pre-**semantic** confusion times... to those thin black disks which play back the music recorded on them" (1981, p.236). **Data** simply occupy some room on a hard disk or on a diskette. A **datum** can be searched for and found in a specific place, while the **brain** has no very

specific places where "something" would be stored. It rather seems to be more of an organized, modifiable, but altogether **autopoietic network** of subnetworks.

2070

MEMORY (Distributed)²⁾

The redundant sharing among numerous **elements** interconnected in a **complex system** of **parts** of the total available **information** present within the system.

Better than to speak about memory as a global **function**, we should consider different types of memories: visual, auditive, lexical, semantic, etc..., which work in different conditions and at different **time scales**.

This type of distributed memory is found in **complex systems** under the form of intercommunicated **nets** among numerous **elements**.

The **brain**, or human **organizations** and societies, or **populations** from the genetic viewpoint seem to be good examples.

No single **element** does possess the total stock of **information** of the system, much less so. However numerous **elements** do share some **data**, or characteristics, or **knowledge**. The positive aspect of this kind of **holographic** or **heterarchic** arrangement is that the destruction of a **part**, even important, of the system does not lead to the loss of much **information**, since the surviving **elements** (neurons, genes or individuals) still possess most of it and are able to retransmit it within a reconstructed **net**.

In order to maintain (or create) **coherence** in such type of distributed memory, some kind **organization in levels** is however needed. We have thus a mix of **heterarchic** and **hierarchic order**.

von FOERSTER introduced the concept of "memory without a record". Memory is not a set of records stored in some specific place in the **brain**: the computer memory is an incorrect **metaphor**.

L. M. ROCHA comments: "By utilizing functionals to change the **functions** of **state-determined** systems, von FOERSTER formalized the idea that memory can be observed in systems which are able to change their own **structure** and therefore its dynamics and **attractor behavior**. Today we name this kind of memory distributed, and the kind of **models** of memory so attained as **connectionist**. The **categories** that a distributed memory system classifies are not stored in any particular **location**, they are nowhere to be found since they are distributed over the entire **dynamics** established by some **network** of **processes** (van GELDER, 1991). They exist however in the form of **attractors** (**eigenstates**) which are nonetheless discrete" (1996, p.377)

This **model** of memory is closely related to **organizational closure**, characteristic of **autopoietic systems**.

It leads to "distributed memory selected **self-organization**" (Ibid)

→ **Distributed meaning (Principle of)**

2071

MEMORY IN ECOSYSTEMS AND SOCIETY¹⁾⁴⁾

J. SENDZIMIR and H.T. ODUM observe that:

"General systems **analogs** of **short term** and **long term** memory are found within ecological succession, **evolution**, internet, and the development of human **culture**. Estimates of **energy** and **transformity** are used to evaluate the **resource** basis for **information** and its **maintenance**" (1998, p. 154)

They add that these values can be "used to consider the **limits** to information in our civilization and suggest policies consistent for global sharing" (Ibid.)

2072

MEMORY (MILLER)^{2) - 3)}

A registered trace of some former **stimulus** and its results, in a **living** or an artificial **system**...

or, the capacity to store perceived **information** for later retrieval, generally in a modified form.

According to K. KRIPPENDORFF, memories are observational **constructs** (1986, p.48).

However M. BUNGE writes that "... memory is the activation of neural **connections**", while "**learning** is the formation of neural **connections**" (1979, p.138).

It seems not yet very clear if these **connections** are merely a potential to be evoked or if they exist permanently.

The first definition, inspired by R.L. ACKOFF and F.E. EMERY (1972, p.76), "... does not require that the memory-**response** be a conscious one".

The same authors define the intensity of a memory as "... the intensity of the **response** that defines it"; the durability of the memory "as the length of **time** over which it persists", and the correctness of the memory as "the **efficiency** of the memory **response** for the **objective** for which it is intended" (p.77).

"Memory" has been a very controversial **concept** among systemists, cyberneticians and computer scientists.

H.von FOERSTER writes: "Let me demonstrate the notion that is computing, rather than signaling and storing these **signals**, which is at the core of **cognitive processes** by contemplating for a moment "memory". For it is precisely the misconception of this higher mental **function** to be a "data storage system" which blocks the vision for the kind of systems we shall need to meet the challenge of the future.

"If memory were a **data storage system** it is easy to show that in order to account for what we know, each of our brains should be the size of a sphere about one mile in diameter packed with nerve cells. However, when of this size, the **operation** to recognize, for instance, the presence of a lion in its field of vision takes this **brain** about ten years. This may be helpful for the lion but, alas, not for the bearer of this **brain**" (1982, p.216).

In synthesis, what our **brain** does is *not* going searching for one specific **datum** in a colossal heap of stored **data**. In von FOERSTER's terms: "... (it) computes the answer to a question, rather than store all answers together with all possible questions in order to respond with the answer... when it can find the question" (p.175).

According to von FOERSTER, we should view memory as a *process* property of the **brain**: "... as if it were a computer whose internal **organization** changes as a result of its **interaction** with an **environment** that possesses some **order**. The **changes** of the internal **organization** of the computer take place in such a way that some **constraints** in the **environment** which are responsible for its orderliness are **mapped** into the computer's **structure**. This **homomorphism "environment-system"** reveals itself as "memory" and permits the system to function as an inductive **inference computer**" (p.114).

Moreover, the main practical feature of cognitive processing in relation to **memory** is that "cognitive living **organisms**... succeed to eliminate quickly all temporal aspects in a sequence of **events** or, in other words,... "time" is abandoned as early as possible in the chain of **cognitive processes**" (1982, p.140) (i.e. the only way to save oneself from the "lion's jaws!").

von FOERSTER wrote this in 1965, when **networks** and **connection machines** had not yet entered into the main currents of **cybernetics** and systems science. Thus the use of the term "computer" should not be taken as meaning any identification of **brains** with classical **sequential** computers which process stored **data** according to strictly deterministic or even stochastic **programs**.

2073

MEMORY OF INITIAL CONDITIONS¹⁾

A perfectly reversible system could be considered as having a perfect memory of its initial conditions, inscribed in its **history**, and thus be able to backtrack to its initial **state**.

This is however not the case for any **concrete system**, with many initial conditions whose **effects** interact in new ways at any instant. As stated by K. BERRIEN: "All memories in any form decay, some at an infinitesimal **rate**. The print of books fade, ... magnetic **patterns** dissipate, and, evidently, whatever the neural traces may be, they vanish. Even if we

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

conceive of **storage** as any *potential energy*, the **second law of thermodynamics** carries with it the increase in **entropy** as an inevitable degradation of all **energies**... Memory can be conceived to be a stored **change** in a system as a consequence of **signal inputs** that are maintained longer by appropriate **maintenance inputs**" (1968, p.42-3).

In BOLTZMANN's statistical interpretation, **entropy** leads the ideally **isolated system** toward maximum molecular **disorder**, i. e. away from any memory of its particular initial and **dissymmetric** conditions.

In turn, any **concrete complex system** must necessarily be highly **dissymmetric** and maintain itself within the **limits** of a **global determinism** which defines its general conditions of existence. But such a **global determinism** allows for local and transient conditions, which may be unconnected *for a while*, and later on recombine in very variable ways, within however the **limits** of the **global determinism**. The **set** of the initial conditions becomes probably blurred during this **process** and possibly disseminated among numerous **elements** or **sub-systems**, as for example, in **populations** or **social systems**.

In this way, the "memory" of initial conditions is not lost, but becomes scattered and can never be fully recovered and reintegrated.

Such a situation may be clearly observed, for example, in the **Markovian matrixes** used by W.R. ASHBY for the study of **populations behavior** (1956, n°9/6).

According to a curious comment by R. THOM, "A solid is quite static. But its interest is that it is a depository of past **actions**, which makes it interesting for the interpretations of **forms**. It is a memory. A liquid has scant memory and a gas, still less, since it takes the **form** of the container in which it is stored" (1991, p.49).

2074

MEMORY (TAXON)

→ **Taxon Memory**

2075

MERIDIAL²⁾

Character of a **translation** along a meridian, or crossing a torus orthogonally to annular **paths**.

This neologism has been introduced by D. Mc NEIL in relation to his general **model** of systems as **toroids**. (pers. comm.)

2076

MESO-¹⁾⁴⁾

A prefix that indicates that some entity corresponds to an intermediate **level** in a **classification**.

Such **classification** can be temporal or spatial.

For ex. "mesolithic" is more recent than paleolithic, but older than neolithic, in archeology.

In **space dimensions**, meso- is bigger than **micro-** and smaller than **macro-**, or **mega-**. M. BUNGE f. ex. describes a big business or a university as mesosocial systems, inbetween families (micro-social) and transnational businesses or the United Nations (mega-social) (1995, p.35)

2077

MESOSCOPIC SCALE

→ **Scale (Mesoscopic)**

2078

MESS^{1) - 4)}

"A system of problems that cannot be decomposed in more simple problems... which themselves are minimeses" (R.L. ACKOFF, 1974, p.21).

"By "mess" ACKOFF means that every human **problem** is associated and involved inextricably with every other human **problem**" (I.I. MITROFF and H.A. LINSTONE, 1993, p.47-8).

Messes are quite frequent in technical, economical and socio-political systems, and result of their **complexity** and **nonlinear** character, which are neither perceived, nor taken into account.

Specific **action** on one or some few **elements** selected within the system does not normally produce the forecasted or expected **effects**, because it is taken unknowingly against some other functional needs of the system.

Messes have a tendency to expand very far from their origin in **space** and **time**, and to pop up again under unexpected aspects.

However, a mess may also offer new opportunities to an acute manager.

ACKOFF has given a considerable number of examples of messes that he met in his career as a consultant.

The basic requirement to manage a mess and make it produce opportunities is trying to focus it from an original angle, which can be understood and appreciated by all **stakeholders**.

In the numerous cases in which a mess affects a natural system or an artificial technological one, human **components** play a most generally basic role.

2079

MESS FORMULATION^{2) - 4)}

Identification of the system of problems and opportunities (in a mess) and **understanding** of the **pattern** of **interactions** among these problems and opportunities, and **constraints** on the **organization's** ability to do something about them (after R. HARNDEN, 1990, p.344).

According to R.L. ACKOFF, a good way to formulate the mess is projecting the future of the **organization** or enterprise if nothing would be done to clean up the mess.

Three aspects are of particular importance:

- obtain a detailed **description** of the **organization** and how it works, internally and in relation to its **environment**
- study the obstructions that block the smooth **development** of the **organization**
- prepare projections extrapolating the present **performance** of the **organization** in its messy conditions, in order to discover the dangers that loom ahead.

HARNDEN states: "The depth of analysis carried out in the mess formulation makes it possible to dissolve **conflict**. It is in this phase that the focus on **learning** is dominant. A proper mess formulation probes deeply and honestly enough to demonstrate to any doubting party that the approach is balanced and respects everyone's **issue**. In mess formulation, the **issues** are reframed until they are stated in terms that recognize existing interests vital to all **parts** and create a shared **purpose**" (p.845).

This view is very close to **co-participative design** (BANATHY - FUSCHL Group), **heterarchical design** (JOHANNESSEN) and **generic design** (WARFIELD).

2080

MESSAGE^{1) - 2) - 3)}

"A **set** of one or more **signs** intended by its producer to evoke a **response** either in another or in himself" (R.L. ACKOFF & F. EMERY, 1972, p.176).

"A scaled and integrated **signal** which has significance or **meaning** for either the **transmitter** in transmitted messages or the **receiver** in received messages" (Ibid, p.272).

Both definitions are very general, in a systemic sense: a message is anything that transmits **information** of any kind (positional, genetic, through gesture, iconic, verbal, symbolic, etc...).

J.de ROSNAY states: "A message is composed of **signals**, **signs** or **symbols** assembled according to a **code**" and adds: "A **set** of messages and **codes** constitutes a **language**... The message emitted from a **source** is codified and next, transmitted through a **channel**..."

Moreover: "... **perturbations** interfering within the **channel**, which are called **noise**, may alter the messages and modify their **significance**" (1975, p.168-9).

Noise may even turn them incomprehensible. But in many cases, they can be recuperated by adequate filtering.

Messages can be compressed, by eliminating **redundancy**, but with an increased risk to their intelligibility due to perturbing **noise** (D. RUELE, 1991, p. 175).

It is interesting to observe that, while a 100% **redundant** message carries no **information** at all, a 100% original message, would not be intelligible, save if it conveyed implicit connotations. Both types are very difficult to produce in practice.

For example, the totally imaginary and senseless word "facrupto" can at least be written in Latin **alphabet**, tentatively pronounced as an English, or French, or Spanish word... and may even in the future become a known example of 100% original non intelligible **information**!

2081

MESSAGE (Ambiguous)^{2) - 3)}

A message thus transmitted that the **receiver** remains unsure of its **meaning**.

The **ambiguity** is generally the result of uncertainty about the **context**, as for example in the case of humour when we are not yet sure where the joke is leading us, or when an imprecise question allows for different replies, as in oracular pronouncements. The problem of **ambiguity** shows that any message is merely a specific combination of some **elements** within a linguistic and situational environment.

→ **Meaninglessness**

2082

MESSAGE in its epistemic environment³⁾

Electronic and human messages are different as the first ones are technically based and the latter ones are **semantically** based, after of course being transmitted through a physical medium.

As explained by L. THAYER: "... in electronic **communication**... the **transmitter** has been designed and programmed to send and the **receiver** has been designed and programmed to receive (and sometimes to process in some way)" (1972, p.101).

Ambiguity in coding is proscribed and **redundancy** is used to eliminate **noise** as completely as possible: "... the "message" must be **invariant** for the **transmitter** and the **receiver** under all conditions. This is the whole point of reliable **communication**" (Ibid).

THAYER pursues: "For humans, on the other hand, the "message" (which itself is a misnomer) must vary with the **context**" (Ibid). This means that the same message in different circumstances or places may be received and interpreted in quite different fashion by different **receivers**. The significance may heavily depend on what B. HOLZNER (quoted by THAYER) calls the "**epistemic community**" in which it is emitted and received.

THAYER adds the important following comment: "Closely related is the conceptual confusion that has resulted from analogizing the concept of "**information**" from electronic **communication theory**, **information theory**, and **cybernetics** into the study of human **communication**" (Ibid).

This kind of "electronic **reductionism**" goes a long way to explain psychologists and sociologists resistance to the **cybernetic** concepts in general, and even their belief that **cybernetics** is not much more than manipulative gadgetry.

2083

MESSAGE (Meta-)^{2) - 3)}

A message on a higher **level** that may modify the interpretation originally given to the message.

G. BATESON gives the following example: "I was lying when I said "The cat is on the mat" (1973, p.218).

He comments: "(this) tells the vis-a-vis nothing about the location of the cat. It tells him only something about the reality of his previous **information**... The **context** (or metamessage) *classifies* the messages, but can never meet it on equal terms" (Ibid).

→ "**Metacommunication**"

2084

MESSAGES (Hierarchies of)³⁾

G. BATESON observes: "... that messages may be about (or 'meta') to the **relationship** between messages of different **levels**" (1973, p.219).

2d order learning is based on **processes** of hierarchization of messages. A good example is Pavlovian conditioning, wherein the **metamessage** comes finally to act as **trigger** for the conditioned **behavior**.

Behavioral and mental **algorithms** act as **contexts** or **metaccontexts** for the interpretation of messages.

2085

META^{1) - 2)}

A prefix used to indicate a higher **level of complexity** or **abstraction**, referring to **models**, **languages**, or systems.

This prefix, mainly diffused by J.van GIGCH and his collaborators, has been occasionally criticized by some users on the ground of its supposed philosophical connotations and arguing that it could be replaced by "**supra-**" or "**super-**".

It is, however, widely used and does not seem to entail **semantic** confusion. Moreover, its meaning is solidly grounded in B. RUSSELL's and A.N. WHITEHEAD's **Theory of logical types**.

E. SCHWARZ observes that it has frequently a **self-referential meaning**: "Examples: **Meta-knowledge**, as **knowledge** on **knowledge**; meta-mathematics, as **mathematics** of the **mathematics**; **meta-communication**, as **communication** about **communication**" (1993, p.7).

Meta- can also imply a **transition** from one **state** or **process** to another, as for example in **metabolism**; or some kind of **generalization**, as when systemics is spoken of as a **metalan-guage**.

2086

META-ANALYSIS²⁾³⁾

"A way of extracting statistically meaningful **information** from lots of small trials" (The Economist, sept. 27th, 1997)

The Economist adds: "... even if they have been conducted in ways that make them difficult to compare "by eye". Its conclusions, however, are only valid if the negative trials are included as well as the positive ones. Leave out the negative ones and the results may be too optimistic".

Such a **method** applied to scientific **experiments** may obviate undue rejections as well as conniving acceptances in the classical process of peer review.

2087

METABOLISM⁵⁾

The **set** of (**synchronic** and **diachronic**) **transformations** which occur in a **living system** and allow it to maintain its **identity** through **homeostatic processes**.

Metabolism is an internal **process** within a system

It follows **rules** that must necessarily be in accordance with the characteristics of the system

For ex. a **living system** cannot metabolize strychnine

These **transformations** are principally biochemical and biological and affect the **matter** and **energy flows** which enter into the system. L.von BERTALANFFY wrote that: "Metabolism is the **maintenance** in a **steady state**" (1969, p.80).

This notion could be generalized:

- 1) to the **transformations** affecting the **information** received by the system;
- 2) to the **meta-living systems** that also transform energy, **matter** and **information**, obtained from their **environment**.

2088

METACOMMUNICATION^{2) - 3)}

A key for **decoding communication**.

The concept is introduced and thus explained by M. MARUYAMA: "Metacommunication is a "decoding key", but *not* the **content** of the **communication**. For example, if I send a mes-

sage, "It is raining in New York", and send another **message**, "The first **message** is false", then the second **message** is a **decoding** key for the first **message**, telling you that a joking **mode** or a deceptive **mode** was used. But the second **message** by itself does not say anything about the weather in New York" (1994, p.69).

Metacommunication may lead to **double-bind situations**, as with the famous Epimenides-the-liar paradox (see "Theory of types", "Metamessage").

Metacommunication thus frames and relativizes **communication**. This is very significant, especially when metacommunication remains implicit, as it is the case in many transcultural **situations**. Transculturated individuals can become victims of their ignorance of implicit metacommunication in the other culture.

2089

META-CONCEPTS^{1) - 3)}

Those concepts of very general character whose span of **validity** covers numerous different types of **situations** and systems.

All **cybernetic** and systemic concepts are meta-concepts. The interconnected **set** of systemic meta-concepts constitutes a **metalinguage** within which specific statements originating in some discipline can be generalized. They can thus be used to emphasize significant **analogies** and **isomorphisms** between the **models** we may construct in different disciplines, related to different systems.

For example, **feedbacks** can be observed in many physical, biological, human and artificial systems, and **autopoiesis** is proper to any kind of **living systems** or systems made of **living systems** (i.e. **social systems**).

Cybernetic and systemic meta-concepts provide guidelines for **transdisciplinarity** because they offer a common **metalinguage** and **meta-models** to specialists, a way to obtain **meta-skills** and avoid costly errors when participating in complex projects.

2090

META-CYCLE²⁾

"A cycle which **embeds** cycles of smaller **periods** and **amplitudes**"

→ **Fractals**; **Self-similarity**; **WEIERSTRASS function**

2091

METAKNOWLEDGE IN CRITICAL THINKING³⁾

J.van GIGCH defines metaknowledge as "knowledge about knowledge". He writes: "We agree with PITRAT (1985) that we must possess metaknowledge in order to be able to evaluate knowledge. Every time that we take **object-level** knowledge through the dialectic **process** of validating logic or raising **abstraction**, we

produce metaknowledge; PITRAT postulates the existence of knowledge and metaknowledge, but rules out the existence of meta-metaknowledge. We disagree with PITRAT, but argue that our disagreement is probably only a matter of definition...

"The **recursivity** of the **dialectic process** ensures that there is always a **metalevel** to which we can resort to prove the logical and **truth validity** of statements. The **recursive** property is only diminished by practical considerations, such as time and **cost**, and by theoretical limits, as stated in **GÖDEL's theorem**, a subject that will be avoided here" (1987, p.325).

It must be said that van GIGCH defines **truth** as meant here as "the **meaning** of a claim in the **context** of its knowledge **domain**".

As to GÖDEL's theorem, it is in any case the foundation of hierarchical **levels** of knowledge, even if it implies a final doubt about limitless **recursivity**. (C. FRANÇOIS, 1993, p.57-76)

van GIGCH also explains: "As knowledge is reconceptualized through the interplay of ever higher **levels of abstraction**, it becomes more complex and hence less liable to modification and **change**. Therefore we contend that knowledge pertaining to higher conceptualization **levels** (metaknowledge) is more difficult to change than knowledge from lower conceptualization **levels** (**object level** knowledge).

The best reason which we can give of this increase in **complexity** is that as we change **paradigm** to explain a new set of **facts**, the new **paradigm** must confront the **validity** of two propositions:

- 1. why the old **paradigm** cannot explain the new **facts**;
- 2. why the old **paradigm** was sufficient to explain the old set of **facts**.

The new **paradigm** has a more complex **set** of propositions to explain than the old one" (1986b, p.97).

→ See also: **Structural differential**

2092

METALANGUAGE³⁾

1) "A language of a higher **order** of logic which is spoken at the **metasystemic level**" (J.van GIGCH, 1986a, p.3 – after St. BEER).

2) A **code** used for speaking or studying another language" (J.Z. YOUNG, 1974, p.295).

J.van GIGCH adds: "Metalanguages are needed to resolve debates, conflicts or **undecidability** which cannot be resolved in the language or logical **structure** of systems at the **object level**" (Idem).

The necessity and nature of metalanguages became obvious after A.N. WHITEHEAD and B. RUSSELL's **Theory of types** and still more so after **GÖDEL's theorem**.

Anyhow, **undecidability** always reappears at the higher considered **level**.

2093

META-LANGUAGE Characteristic requirements^{2) - 3)}

According to BLAUBERG et al: "There are two basic requirements for the meta-language: 1. it must include the language-object (all the expressions of the language-object must be translatable into those of the meta-language), and

2. it must be richer logically than the language-object (it must have the necessary logical means for describing the **structure** and other properties of the language-object)" (1977, p.198-9).

It seems quite possible that only some of the concepts of **general systems theory** could be translated into a formalized meta-language, as stated by BLAUBERG et al. themselves.

2094

METALINGUISTIC RULES³⁾

"The rules which govern how words and sentences shall be related to **objects** and **events**" (G. BATESON, 1973, p.153).

BATESON states: "Denotative **communication** as it occurs at the human **level** is only possible *after* the evolution of a complex **set** of metalinguistic **rules**...

"It is therefore appropriate to look for the **evolution** of such metalinguistic and/or meta-communicative **rules** at pre-human and pre-verbal **level**" (Ibid).

For a thorough exploration of this subject, see A. KORZYBSKI's "Science and Sanity" (1950).

2095

META-METAMODELING^{3) - 4)}

The ultimate **frame** for **validation** of **decision making**, where cultural and social basic **values** are taken into consideration.

At the **decision making level**, sound **modeling** and **metamodeling** do not yet suffice, as no **design** or project can prosper, nor be willingly and definitively accepted without a reasonable **consensus** of all **stakeholders**.

2096

METAMETHODOLOGICAL INQUIRY^{2) - 3)}

An investigation "regarding **systems methodologies** rather than **knowledge** regarding systems" (G. KLIR, 1991, p. 106).

KLIR explains how any particular **systems methodology** can be compared with others. "Metamethodological inquiry can also be employed for validating various methodological principles that are based upon the investigated **methodologies**" (Ibid).

KLIR asserts that computers are very convenient tools for this kind of inquiries.

2097

METAMODEL²⁾ - 3)

"A **model** of a higher **level of abstraction** which ...maps the properties of lower systems **models** into propositions of a higher **level of abstraction**" (J.van GIGCH, 1987, p.3) (after St. BEER).

To this definition, van GIGCH adds the following comment: "Of necessity, the metamodel is conceptualized in a metasystemic **language** or metalogic which can decide propositions and reconcile arguments which cannot be decided or reconciled in the **language** of logic of lower systems **models**" (p.3).

The unavoidable need for **validation** through metamodels is closely related to **GÖDEL's theorem**.

2098

METAMODELING²⁾ - 3)

"A **process of design** which is carried out at the **metalevel**, and by which we define how the **process of modeling** (at the **object level of abstraction**), is to be carried out. (J.van GIGCH, 1992 p.3)

In another work, van GIGCH commented: "Until recently, the accepted approach to **problem-solving** consisted of the formulation of a **model** and applying the solution obtained from the **model** to the real world. However, this **methodology** bypasses the important step of metamodeling, that is setting the **rules** of logic by which the **model** itself is to be designed. Metamodeling, or the Science of Modeling, is involved with designing **metamodels** and with designing the **process of design**" (1978, p.3).

In his more recent paper, van GIGCH adds: "Metamodeling defines the **epistemology** or **design foundations of modeling**", (thus establishing the foundations "... of the reasoning **process**, guarantees of **truth**, proofs, axioms of **validity**, or any other logic which underlies a **methodology**" (Ibid).

Decision making should ever be framed within a **metamodeling level**, which implicitly involves cultural and social **values**: It is now time to verify the **fitness** of any **model**, specially those of **complex systems** (frequently very much partial and biased as they are), in order to protect ourselves against the **side effects** that some important but neglected aspects of the modeled **situation** may bring in their wake.

2099

METAMORPH¹⁾ - 2)

A more **complex system** resulting from the recombination of characters formerly unconnected.

This happens more or less frequently in **heterogeneous populations**.

Metamorphs appear frequently in technological **evolution**. C. FARRELL gives a curious example: "... metamorphs arise when disparate ideas are brought together - such as writing and playing piano. Combine them, and you get the first typewriter, which actually used keys from a piano" (1993, p.39).

Another metamorph is the "motor-car", literally, a cart or chariot equipped with a motor!

2100

METAPATTERN: a pattern of patterns¹⁾²⁾

The concept has been introduced by G. BATESON (1979). In each of the different **levels of complexity** of a system, some pattern can be distinguished for the **description** of the ways the **elements** at that level interconnect and interact.

As observed by BATESON, no order of **interaction** among **elements** can be totally independent from its **context**, be it co-systems, or higher or lower **levels** within the system, or some features external to the system as a **whole**.

This **dependence**, or **interdependence** implies the existence of higher (or lower) **patterns** of interactions which are in some way related to the pattern originally considered.

These **relationships** between different patterns can be named metapatterns

As expressed by BATESON "without context, there is no **meaning**". This is why a supposedly "**isolated system**" is a purely abstract notion, as it cannot have any exchange of **matter, energy or information**. This situation condemns it moreover to internal **entropic** annihilation

For another angle of view, metapatterns have a dynamical character and are frequently recurrent. This is as obvious in **history** as in music, for instance (A. GOPPOLD, 2000, p. 110-11)

2101

METAPHOR¹⁾ - 3)

"A linguistic form which is used to acquire and communicate **knowledge** through a transfer of **meaning**" (J.van GIGCH, 1993, p.45).

Etymologically, a "meta-phor" is a carrying over device. Accordingly, a metaphor is a transfer of the **meaning** of a word, usually from concrete to abstract, by its inclusion in a unusual **context**.

Example: "the root of the difficulties". Of course, only plants have roots, but the word "root" may be used to describe and convey the more abstract notion of the **basic** origin or the difficulties.

In a more general sense, as expressed by C. MESJASZ: "Metaphors involve the transfer of **information** from a relatively familiar **domain**... to a new and relatively unknown one" (1992, p.1174).

The positive aspect of this transfer is that it frees **creativity** by crossing hitherto blocking **paradigmatic limits**. However, as metaphors create **analogies** within the mind, they should be taken and used with much care because they may perfectly well generate **false analogies**, or at least overextended ones. Propaganda, for example, makes an enormous use of unsound metaphors.

MESJASZ observes rightly that while: "... metaphors and **analogies** (are) inherent parts of the **language**... (their) applications... can have a strongly normative character, frequently based on various ideological assumptions" (Ibid).

Metaphors should be thus carefully scrutinized, especially in systemics and cybernetics, whose **models** could easily be weakened, or even perverted, by their imprudent use. A satisfactory **process** of elaboration should lead from metaphor through confirmed **analogy**, to **homomorphic models** of **concrete systems** or **situations** and, when possible to general **isomorphic** and **transdisciplinarian** more abstract **models**.

Quoting G. MORGAN (1980), J.van GIGCH writes: "Metaphors can be used "to understand one **element** of experience in terms of another... They provide a **framework** to structure **perceptions**... (and they have) important implications for the **process** of theory construction" (quoted Ibid, 1993).

According to H. MALTA MACEDO: "A metaphor, although sharing properties of both **component** units, conveys a new specific **meaning** rooted in the fused total areas of transected, enhanced attributes" (1992, p.677).

Metaphors offer interesting **heuristic** openings, but then only if they are correctly critized and evaluated, a point made by D. and G.A. MIRHAM who insist on the necessity to seek confirmation of speculative metaphors, or of their eventual rejection.

They also state that the linguistic scrutiny of the metaphor is an important stage of its critique (1975, p.51).

H. ATLAN expresses the following about the "genetic program", a very apt example of metaphor's limitations and dangers: "The problem with the genetic program is that it is a metaphor, which should not be pushed too far because it leads to practical difficulties and the only way to get around it is to modify the idea of a computer **program** to such a point that almost nothing is left from the metaphor.

"Already from the beginning of molecular biology - and this can be found in every textbook - the so-called genetic **program** was described as a very peculiar **program**, since it needs the products of its reading and execution to be read and executed; or else, that it functions as a self-programming **program**. Additional questions were raised about the **language** in which it is written and it was recog-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

nized very soon (note: By B. SHANON and D. HOFSTADTER) that the genetic **code** certainly does not constitute a computer **language**, being at most a **lexicon**" (1972).

As a conclusion, it could be said that metaphors are most useful through a consistent critique.

About the use of metaphors in social sciences, and particularly, in **communication**, K. KRIPPENDORFF observed that "most social scientific theories can be shown to have grown out of ordinary folk wisdom" (1993, p. 3). He gives numerous examples. He moreover questions the consequences of this not very conscious phenomenon. Among them he discusses

- communicative **competence**
- communicative authority
- self-authorization in mass **media**
- impoverished communication (specially through **manipulation**)
- surrender of cognitive authority

As a conclusion, systemists should always carefully scrutinize metaphor-tainted **concepts** and **models**.

→ **Frame of reference; Information; Map territory relation; Model accuracy; Model as a system; Symbolic processing**

2102

METAPHOR (Organismic)^{3) - 4)}

A metaphor "that represents the **organization** as an **open system** seeking to adapt to the turbulent **environment** it is confronting" (M.C. JACKSON, 1992, p.219).

JACKSON comments: "The tendency to treat **organizations** as if they were *organisms* has been especially pronounced among advocates of the systems perspective in **organization theory**" (p.24).

This metaphor is of course interesting, but it does not clarify very much the individual **roles**, as they are or as they could be, nor the **meaning of values and norms in organizations**.

2103

METAPHOR THEORY (Conceptual)¹⁾³⁾

M. DANESI has given steps toward the elaboration of a general theory of metaphors, which amounts to a kind of theory of **abstractions** constructions (M. DANESI, 2001, p. 5-24)

The general idea is about our way to construct embracing **frames of reference** through successive (**meta-**) **levels of abstraction**.

This attempt is somewhat akin to KORZYBSKY's **structural differential**, but also offers new insights.

DANESI starts with a **layering theory** of metaphors, (which is itself a metaphor!), related to PEIRCE's concepts of firstness, secondness and thirdness.

To begin with, DANESI distinguishes various types of metaphors as:

- animal ones, as for ex. "the professor is a snake"; "he is a real hog"; "she is a true pussycat"

- visual ones as for ex. "there is more in it that meets the eye"; "from the viewpoint", "see eye to eye"; develop a "worldview"

At a second level of abstraction more abstract metaphors appear:

- "he is a voracious reader"
- "Darwin is the **father** of modern biology"
- "That idea is not in **vogue** any longer"
- "That theory needs **support**"
- "His views have contemporary **offshoots** or, in a **culture** strongly influenced by markets:
- "That idea just won't **sell**"
- "That's a **worthless** idea"

Finally, DANESI writes about "meta forms", "metaforms", "metasymbols" (p.21) and shows how the use of metaphors provides a synthetic **framework** for the **understanding** of the way human abstract systems are constructed.

He notes that this "basic human tendency to think of abstract concepts iconically and through **association** was already pointed out by Giambattista VICO (1682-1744) the Italian philosopher" (p.8)

→ **Concept; Constructivism; Level; Pragmatism: a systemic view**

2104

METAPHORIC FRAMEWORK¹⁾²⁾⁴⁾

H. BENKING and A. JUDGE observe that the "intellectual product" of international conferences of all kinds "takes the form of complex declarations and programmes"

They consider that "the challenge is to configure the conceptual **elements** into a global comprehensible form. This is necessary to counteract the tendency to generate an **asym-metric** agglomeration of elements" (1994)

While this is obvious, it is also obvious that the actual form of the post-conference declarations is sometimes a true reflection of contradictory intentions and interests of the participants...and even of the muddled thinking of some of them.

The authors add: "In addition to its mnemonic function, a metaphoric framework can then highlight the possible missing elements as well as suggesting ways of understanding interesting functional relationships between such elements" (Ibid)

This is again obvious, but **transparency** may be in some cases ignored by some who want to better dissimulate covert intentions. Moreover, the selection of the metaphoric framework itself could easily become the source (or the pretext!) of endless and inconclusive debate

2105

METAPHORS (Classes of)²⁾

H. BENKING and A. JUDGE write: "There is a need to distinguish classes of metaphors offering different advantages and disadvantages. Typically they would include: geometric **forms** (cube, sphere, polyhedra in general), artificial forms (townscapes, house, room), natural forms (landscape, trees, etc.), systemic **structures** (highway systems, pathways, flow systems), dynamic systems (atomic, molecular, planetary, galactic systems), traditional **symbol** systems (mandalas, sand paintings, etc.)" (1994)

In fact, what the authors call metaphors can in most cases be also considered as **models**.

To their listing an important addendum would be **topological graphs**, **matrixes** and mathematical curves (for ex. exponential, asymptotic, logistic, gaussian)

The authors add: "Of special interest are those **sets** of metaphors which permit **inter-transformation** with minimal loss of conceptual integrity (in terms of maintaining **relationships** between **data** referents) (Ibid)

And: "With **information** beyond a certain degree of **complexity**, it is questionable whether any single metaphor is adequate as an **inter-face** for adequate comprehension. This is best exemplified by the wave/particle metaphors used to comprehend fundamental physical systems" (Ibid)

Moreover: "It is equally desirable to understand the use of metaphors in terms of the alternation between perspectives which provide a sense of depth that would otherwise be unavailable. Such "depth" is distinct from that obtainable from any 3-D metaphor which although it offers depth, is cognitively not as significant as that offered from the cognitive integration of two contrasting metaphors. Such "depth" is only achievable by alternation between metaphorical interfaces (as the wave/particle example suggests)" (Ibid)

As an interesting tool, the authors also propose the creation of a "library of metaphors"

2106

METAPHORS (Systemic and cybernetic)^{1) - 3)}

"General **constructs** which can be associated with general tools of thought for organizing **knowledge**" (P. PATON, 1999, p. 150)

"Examples of systemic metaphors include: **machine**, **text**, **organism** and **society**" (Ibid)

Systemic metaphors should of course be used in a guarded way because of possible abuses of **analogies** that can easily lead to dubious interpretations and statements.

They may however reveal structural and/or functional characteristics of entities through researching apparent or real **similarities** between entities of different natures or at different levels. A good example is J. MILLER's **cross level research in living systems from cells to societies**.

D. GREGORY observes: "What is important about perceiving the metaphors that we use is that different metaphors lead to different axioms, problems and **goals**: they constrain our thinking as much as they allow it to proceed in particular directions. They are both vantage points and prisons. They simultaneously support both great clarity and mind-binding impenetrability" (1993, p.69).

Consequently, a census of systemic metaphors could be very needed to create a clearer conscience of their own uses of **language** by systemists and cyberneticists.

Originally, systemic metaphors were basically **organismic**, while cybernetic ones were **mechanicist**.

As to the first ones, R.M. SNOW observes: "... the **organismic** metaphor is widely used in both **functionalist** and **structuralist** writings as well as in works of **general systems theory**. Functionalists portray systems as pursuing **goals** within "**environmental**" **constraints**. They also discuss the **dynamics** of social **groups** in terms of "**development**". Structuralists have coined an **organismic** term of their own: "genesis", used to label systemic **changes** of great magnitude. It is often used together with the concepts of "**development**" and "**evolution**" (1993, p.142).

Cybernetic metaphors, through the concepts of **feedback**, **regulation** and **control**, were at the beginning basically translated from engineering. This provoked a strong resistance from social scientists, but was more or less tolerated by biologists, who were already acquainted with the concepts of **homeostasis** and **regulation**. Later on, cybernetics diverged in two directions, with new and generally more accepted metaphors. First, M. MARUYAMA introduced the **deviation-amplification model** of "**development**", somehow related to the **organismic** metaphor. Next, H.von FOERSTER, H. MATURANA and F. VARELA introduced **eigen behavior**, **organizational closure** and the **observer-actor**, all of which are non-mechanicist.

SNOW also observes the existence of what could be called the **digital** metaphor: "... **communication** theorists have built their central scheme around opposing pairs: sender versus receiver and **message** versus **noise**. **General systems models** based on **binary logics** used to simulate a wide variety of **behaviors**" (p.143).

More formal metaphors appeared from the seventies on: "catastrophes", "fractals", "fuzziness" and "chaos", for instance. These very

terms imply a metaphoric bias, which may – and has – lead to abuse.

→ **Glue**

2107

META-POLICY⁴⁾

The **management** of **complex systems** in order to obtain the best possible **long-term** results.

This kind of **management** "seeks simplicity, but distrusts it" (A. RAPOPORT).

Its principal weapons are **meta-models** and **meta-tools**. It tries to avoid **short-time** expediency, mistrust **short-term** extrapolations and **sub-optimization** (brought about by unilateral **maximization**).

2108

METAPOPULATION²⁾

A variable global population composed of **patches** shifting and fluctuating in time.

L. PITELKA et al., who use the concept in vegetal **ecology**, write that some "local **extinctions** can be balanced by **colonizations**" (1997, p.469).

However an excessive **fragmentation** into very reduced populations widely separated may lead to total **extinction** or at least **extinction** of some varieties.

There are also metapopulations in animal species and even possibly in human trades and cultural traits.

2109

META-SKILLS (Systemic)²⁾

The skills obtained by the use of systemic and cybernetic **concepts** and **models**.

The aim of **General Systems** and **Cybernetic methodology** is the shaping or generalization of **concepts** and **models**, which appear recurrently in various or many specialized disciplines.

The main specific skills obtained by their use are an enhanced capacity to understand the basics of other disciplines, the capacity to integrate one's own **action** within professionally or culturally **heterogeneous groups**, more facility to tackle complex **situations**, by obtaining an integrated view of their nature and possible **transformations** through **time**.

2110

METASTABILITY²⁾

The condition of a system which remains stable only in the absence of even a slight **stimulus**.

As observed by E. JANTSCH: "Stability is not a notion which might govern (**human**) **systems** over very long **periods**... Systems of high **complexity** trade **stability** for richness in **adaptability**" (1975, p.62).

Metastability manifests a system's readiness to adopt alternate states of **stability**. It is a border condition, depending on merely marginal **stability** of the system's **environment**, which should remain "benign", to use R.N. ADAMS word (1988, p.24).

Such a condition exists in a quite widespread variety of systems. The **stimulus** is generally the introduction into the system of some "seed" or "nucleus". Once this occurs, the **dynamics** of the system suddenly changes, through a kind of flip-over (or "**catastrophe**").

This **phenomenon** is well known in physics (condensation or crystallization of supersaturated solutions); in epidemics (explosive pandemics); in economics (market reversals) and in societies (sudden surge or reversals in beliefs or collective **behaviors**).

The basic condition for metastability seems to be a relative **independence** of the **elements** of the system. See: "**Systems (Composite)**".

A. LOTKA stated: "Dynamically, the characteristic of a metastable **equilibrium** is that the thermodynamic potential of the system, though a minimum, is not an absolute minimum" (1956, p. 151).

R. FIVAZ adds (quoting G. NICOLIS and I. PRIGOGINE -1977, as well as R. SWENSON – 1989, and J. WICKEN – 1989b): "In metastability **regime**, **transitions** from simple **structures** to more complex **structures** take place only if the **rate** of **entropy** production is increased. This theorem is central in the theory of spontaneous **complexification** and establishes the DARWIN-like relationship between **structure** and **function**: only **structures** with a superior functional **time rate** are selected. The corollary is that, in the long run, systems will acquire the best performing **structures** that their couplings can possibly support" (1991, p.24-25).

R. FIVAZ also emphasizes that metastability **transitions** are fast and global (p.21).

These views seem related to St KAUFFMAN's "**edge of chaos**" (1993), where the maximal **instability** results of **dissipative structuration** at thermodynamic **instability thresholds** leading to **bifurcations**, conducive in turn to higher **levels** of **entropy** production, somehow compensated by increased **complexity**.

2111

METASYSTEM^{1) – 2)}

"A system over and above a system of lower logical **order**" (J.van GIGCH, 1986a, p.3) (After St.BEER).

J.van GIGCH comments: "...and therefore capable of deciding propositions, discussing **criteria**, or exercising **regulations** for systems that are themselves logically incapable of such **decisions** and discussions, or of self **regulation** (because the metalogic is inaccessible to the system's logic, or the **metalanguage** is capable of statements inexpressible in the system's **language**)" (Ibid).

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

A metasystem is a system of second **order**, i.e. describing "the **change** from one system to another in the delimited **class**... by a replacement procedure that is **invariant** with respect to the **support** employed" (1991, p.62). Such a procedure can be applied **recursively** and produce metasystems of second order, and so on.

M. BUNGE enounces the following axioms: "Every conceptual and every **symbolic system** of human **knowledge**, is or can be **embedded** in a wider system of the same kind;

"Every **concrete system**, save for the **universe** as a whole, can be included in a larger **environment** with which it exchanges **matter** or **energy**" (1993, p.215).

Let us observe anyhow that the "**universe**" is in fact the abstract – and hypothetical – keystone for the whole logical cathedral. Generally, man is a constructor of metasystems, many times unwittingly, as the *motives* to construct **controls**, **regulators** or **rules** are not included in the same.

2112

METASYSTEM PARADIGM²⁾ – 3)

"...A form of **metamodeling** which is used to conceptualize and study **decision-making** in **complex hierarchical systems** at several **levels of recursion**" (J.van GIGCH, 1986a, p.3).

van GIGCH explains: "... the **organization** is conceptualized as a **hierarchy** of **control** systems. A **control** system consists of a **controller** (CR) which exercises control over a controlled system (CS) which in turn, interacts with an **environment** (E). At the same time, there exists another **controller** – a **metacontroller** (MCR) – which exercises control over the **control** system C, made up of CR, CE, and E. The addition of a meta-metacontroller (MCR') defines **control** at the second **level of recursion** where MCR' exercises **control** over the **control** system C' made up of CR', and CS', and E'. It is to be noted that MCR from the first **level of recursion** becomes CR' at the second. Similarly, the control system C becomes CS'. **Environment** E and E' are not necessarily equivalent or **isomorphic**" (1986b, p.69).

2113

METASYSTEM PARADIGM: Epistemological status³⁾

J.van GIGCH clarifies as follows the status of the epistemological questions which the meta-system paradigm attempts to answer

"Epistemological questions for which the metasystem paradigm does not hold answers

1. The question of problem definition: How should the problem be defined: "In everything there is everything"
2. The problem of **coherence** or of **holism**: How are the **boundaries** of the irreducible **whole** defined?

3. The question of **complexity** and solvability: Reality is complex but complex **models** cannot be solved

4. The question of 'idealism' vs 'realism': The idealist propounds impractical solutions which consider the **whole**; the realist present nearby solutions which are practical but nearsighted.

"Epistemological questions for which the metasystem paradigm holds answers

1. Problem of **optimization** and **suboptimization**: Can we really optimize? What is **centralization** and decentralization?
2. Principle of **invariance**: Is there **isomorphism** between systems **levels**?
3. The **ontological** question: Do **hierarchies** really exist?
4. The guarantee of **truth**: How do we guarantee **truth** or the **validity** of our solution?
5. The question of **observability** and of **control**: Interplay between **observer/designer**, **description** and prescription. Role of **purpose** in **teleogenic** systems". (pers. commun.)

2114

METASYSTEM TRANSITION THEORY¹⁾ – 2)

A general theory of evolutionary **change**.

MST has been proposed by the Principia Cybernetica Group (F. HEYLIGHEN, C. JOSLYN and V. TURCHIN).

This is a theory about "the primary act of **evolution**, the free and spontaneous **emergence** of higher **levels of organization and control**...

"The **phenomena** explained in terms of metasystem transitions include the origins of life, of sexual reproduction, of multi-cellular **organisms**, of neural **organisms** capable of coordinated **action** and **learning**, of thought and **language**, and of human society and industry. In the future we predict the development of global human society and human meta- or super-beings, which preserve the cybernetic **organization** of human minds through direct human-machine and human-human **connections**" (1992a, p.509).

More than a theory, this is a general hypothesis that should be researched more deeply. This is the announced goal of the Principia Cybernetica Group.

Ch. FRANÇOIS proposes an "Integrative view of Meta-System Transition" in relation to various systemic evolutive **models** as **chaos**, **deviation-amplification processes**, **dissipative structuration**, **disymmetries**, **hypercycles**, **organizational closure**, etc... He applies the concept to the general **evolution** of humanity, including the present trend toward world **integration**. (1995, p.173-79).

→ **System (Meta-) Transition**

2115

METATHEORY OF SYSTEMS RESEARCH³⁾

"The general principles of constructing **knowledge** concerning the system **objects**"... or "a theory of systems theories" (I.V. BLAUBERG et al, 1977, p.195).

P. CAWS wrote: "Systems theory is a way of looking at systems, but theories themselves are also systems. They are composite **wholes** whose **parts** are propositions, related to one another in complex and dynamic ways...

"The chief function of theories,... is to anticipate the **behavior** of physical systems. If in theory the device blows up, in practice it had better not be built that way" (1968, p.3).

A theory aims at being **isomorphic** in some respect with some **concrete systems**. It can work if: "... its function is *to be* adequate to the world."

However : "Questions about the adequacy of scientific theories, like questions about their logical **structure**, their origins, their usefulness, etc., are *metascientific* questions; and a number of metascientific disciplines – the philosophy of science, the history of science, the sociology of science – have grown to deal with them. These disciplines, however, are not simply descriptive, they are theoretical to, or better *metatheoretical* – ways of looking at scientific theory, or ways of looking at ways of looking at things" (p.4).

In this way, the concept of an entity functioning as a **whole** appeared in various disciplines and we have thus an interpretation of the **cell** as a system, of the **brain**, of the individual, of the business enterprise, or a **culture** in the anthropological sense as systems. In each case the corresponding systemic theory seeks and finds some specific **isomorphies** between the constructed **model** and the **concrete system**.

But we may advance further: *isomorphies can be discovered between models constructed in different disciplines*. Systems of different kind tend to be, each in their way and at their **level**, **autopoietic**, **heterogeneous**, **hierarchical**, etc... It is thus possible to construct a general systemic **model** of any of these characteristics and to study its necessary **organization**. Why, for example, must all systems be **heterogeneous**? What has **heterogeneity** to see with **wholeness**? Etc...

Or to go back to CAWS and to BLAUBERG, SADOVSKY and YUDIN, we may be able to construct a theory of systems theory, principally by studying the **isomorphies** between **models** and their deeper reasons.

The conclusions thus reached at can then be applied very generally to any **object** amenable to a systemic **model**.

It is still possible to go farther and to try understand how and why our **brain** is able to construct this type of general **modelization** and how and why we are able to reach **consensus** about this **process**.

2116

META-TOOLS²⁾

The collection of systemic and cybernetic devices and **models** that can be used to tackle complex **situations**.

Meta-tools are specifically directed to the **integrative** and the **nonlinear processes** that take place in multi-connected **networks** within **complex systems** or in their **interrelations** with their **environment**.

2117

META-UNCERTAINTY³⁾

"The uncertainty about the accuracy of estimating the uncertainty of a **class of events**" (K. KRIPPENDORFF, 1986, p.49).

KRIPPENDORFF writes: "In **information theory**, meta-uncertainty is calculated on the probability **distribution** of possible samples drawn at **random** from a hypothetical **universe** having the same uncertainty or **entropy** as the sample actually observed... By the **law of large numbers**, meta-uncertainty decreases with increasing number of **observations**" (ibid).

2118

METHOD²⁾

A **procedure** that can be regularly applied to solve some kind of **problems** or to manage some types of **issues**.

According to T. KOTARBINSKI, "a method always implies a way of acting" (1995, p.26). However "some people define a method as an intended way of acting, or a way of acting of which the **agent** is conscious" (p.27).

One should say that, as methods seem proper to human beings, their uses are always "intended". It seems however possible that a method can be applied in a non-conscious, or in a sub-conscious way, as for instance when driving a car.

KOTARBINSKI relates methods - and **methodology** - to the uses of practical skills (ibid).

→ **Program; Routine**

2119

METHOD (DESCARTES discourse on)³⁾

In this famed piece of scientific philosophy, DESCARTES (1596-1650) enounces as follows the four "precepts" to "conduct one's reason" in a correct way:

"The first was never to accept anything for true which I did not clearly know to be such; that is to say, to avoid carefully precipitancy and prejudice, and to comprise nothing more in my judgment than what was presented to my mind so clearly and distinctly as to exclude all ground of doubt.

"The second is to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.

"The third, to conduct my thoughts in such order that by commencing with **objects** the simplest and easiest to know, I might ascent by little and little, and, as it where, step by step, to the **knowledge** of the more complex; as-signing in thought a certain order even to those **objects** which in their own nature do not stand in a relation of antecedence and sequence.

"And the last, in every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted" (S. CUMMINS & R.L. LINSOTT's translation, 1947, p.175-6).

These concepts have dominated scientific research for more than three centuries and led to considerable progress, through an ever increasing specialization.

However, the following caveats should be taken into account:

- DESCARTES' concept of evidence is subjective and implicitly based on an **ontological** absolute. This remains largely true even when the "evidence" is inter-subjectively accepted through a wide **consensus**.
- While "dividing the difficulties" may indeed be useful in many cases, it easily leads altogether to severing **links** and **interactions**, i.e. destroy the very nature of **complex systems**.
- While DESCARTES third precept about climbing back toward "the more complex" is sound, he does not give any **method** to re-construct the severed **links**.
- His "complete enumerations and general reviews" can never give a complete security that "nothing has been omitted", since he gives no **criterion** for **evaluation** on this supposed completeness.

Even if the historical usefulness of Cartesian method has been massively demonstrated, the above objections explain why **reductionism** is insufficient for the satisfactory study of **complex systems**.

2120

METHOD (Scientific) and CHAOS^{2) - 3)}

J. CRUTCHFIELD et al point out that: "The existence of **chaos** affects the scientific method itself. The classical approach to verifying a theory is to make **predictions** and test them against experimental **data**. If the **phenomena** are **chaotic**, however, **long-term predictions** are intrinsically impossible. This has to be taken into account in judging the merits of a theory. The **process** of verifying a theory thus becomes a much more delicate operation, relying on statistical and geometric properties rather than on detailed prediction" (1989, p.48).

It is by now clear that only the most simple systems - those whose **dynamics** involves only two, or maximally in some cases three independent **initial conditions** - can be studied by using the traditional method, which should,

from now on, be considered merely as a specific aspect of a quite more general method to be applied to complex systems whose determinism is merely global and not narrowly constraining. The principles of this new method are only starting to emerge now.

See in this respect the insightful comments of the quoted authors (p.48-49).

2121

METHOD (Systemic)^{2) - 3)}

J.L. LE MOIGNE, after a sharp critique of the famous Cartesian four principles (see **Method (discourse on the)** enounces in a somewhat jocular way his own four precepts for a "new discourse on the method", in this case, the systemic method:

"The precept of **relevance**: Acknowledge the fact that any **object** that we consider is defined in accordance to the explicit or implicit intentions of the **model** builder. Never refrain to doubt our definition if our **perception** of the **object** becomes modified in relation to a modification of our intention.

"The precept of globalism: Always consider the **object** whose **knowledge** we seek as an immerged **part**, active within a greater **whole**. Perceive it first globally, in its functional **relation** with its **environment**, without bothering too much to establish an accurate **image** of its internal **structure**, whose existence and uniqueness should never be taken for granted.

"The teleological precept: Interpret the **object**, not in itself, but better by its **behavior**, without seeking an a priori explanation of such **behavior** by some law supposedly implied in some **structure**. Conversely, try to understand this **behavior** and the **resources** that it puts to use in relation to the "project" that the **model** builder adscribes to the **object**. Take the identification of these hypothesized projects as a rational intellectual act, admitting that their demonstration shall very seldom be possible.

"The principle of **aggregation**: Acknowledge that any **representation** is a simplification, not by some omission of the **model** builder but in a deliberate way. Consequently, seek some recipes to guide the **selection** of **aggregates** to be considered as relevant, and exclude the illusory **objectivity** of an exhaustive census of the **elements** to be taken into account" (1990, p.23).

These "precepts" are, of course, quite at variance with those of traditional **reductionism**, which count with a long history of successful results in many specific specialized fields. They do not replace ordinary scientific method, but complement it for the modeling of **complex systems** taken as **wholes**.

Apparently, what LE MOIGNE calls "method" - probably in traditional reference to DESCARTES - is called "methodology" by other authors, for whom a methodology is a *set of methods* of various types (see next heading).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

G. KLIR, for instance, writes: "It is the most fundamental commitment of systems methodology to develop methods for solving genuine systems problems in their natural formulation. Simplifying assumptions, if unavoidable, are introduced carefully, for the **purpose** of making the problem manageable and, yet, distort it as little as possible. The methodological tools for dealing with a problem is of secondary importance; they are chosen in such a way as to best fit the problem, rather than the other way around. Moreover, the tools need not be only mathematical in nature. They may consist of a combination of mathematical, computational, **heuristic**, experimental, or any other desirable methodological traits" (1993, p.39).

In any case, systemic method, (or methodology?) properly, is not referred to a specific trade. It is based on the search for coherent **wholes** clearly distinguished from each other and from their general surroundings. The characteristic methods to study these systems would be the use of structural and functional **isomorphisms** with the help of specific systemic and cybernetic concepts as for example **autopoiesis**, **regulation**, **structural dissipation**, etc.

2122

METHODOLOGICAL PLURALISM ²⁾

Many discussions between authors proposing different **methodologies** for the study of **complex systems** led to some confusion about supposedly contradictory claims.

There is even some danger that these controversies could obscure the respective merits of different **approaches**. M. JACKSON, after a careful consideration of various proposals, proposes a definition of the kind of pluralism that is required: "Pluralism needs, as an approach to managing complex problems, to employ a meta-methodology to take maximum advantage of the benefits to be gained from using methodologies premised upon alternative **paradigms** together, and also encourages the combined use of diverse **methods**, **models**, **tools** and techniques, in a theoretically and methodologically informed way, to ensure maximum **flexibility** in an intervention" (2000, p. 387).

A useful collection of papers edited by J.C. MINGERS and A. GILL (1997) also focuses on multimethodology.

Still another pluralistic methodology has been proposed by A. TAKET and L. WHITE, under the name of PANDA (Participating appraisal of needs and the development of action) (1998, p. 153-158)

→ **Conceptual blocking; Experimental frame; Frame of references**

2123

METHODOLOGY ¹⁾ – 3)

Any **set** of principles, procedures, practices and techniques concerned with some scientific discipline.

According to K. KRIPPENDORFF: "The aim of methodology ... is to describe and analyze not the **objects** or the products but the **processes** of scientific inquiry, to investigate the potentialities and limitations of particular techniques, to reveal their presuppositions and **epistemological** consequences, to suggest structural reasons for successes and failures, and to develop, test and offer generalizations about scientific procedures" (1986, p.50).

Methodologies evolve in relation to dominant **paradigms**. For example, until about 100 years, methodologies based on strict **linear determinism** where taken for granted and dominant. Later on, statistical methodologies gained a hold. And more recently, methodologies adapted to the study of **nonlinear complex systems** are emerging.

In any case, even if every discipline has its own methodological requirements, there is a **level** of general scientific methodology (in constant evolution) whose features supersede more specific, but also methodological aspects.

W. ACAR gives two different definitions for methodology, the first one by C. SCHOLZ (1987, p.53): "(Methodology) deals on a **meta-level** with the nature and creation of concepts suitable for the development and implementation of **methods**."

Methods thus viewed would be the actual tools, say, for example mathematical analysis, or MILLER's **cross-level hypothesis**, or case studies in psychology.

Next, ACAR gives his own definition: "The overall world view, **meaning** and **action** system governing research activity is the field of **inquiry**" (1987, p.120).

This definition is closely related to the one ACAR gives of "**paradigm**". But such closeness is debatable, as shown by the opinion forwarded by J.van GIGCH: "We distinguish a **paradigm** from a **methodology** by indicating that a **paradigm** is usually "**content**" or "substance-free" in the sense that it applies to many problems in a **domain** regardless of their specific **content**, whereas a methodology is a problem oriented procedure or approach which incorporates a particular **paradigm**" (1993, p.44).

B. BANATHY gives a more restricted definition, fit for disciplinary practical uses: "... a **set** of coherent, related, and internally consistent **methods** applicable to pursuing disciplined **inquiry**". He adds: "In the scientific **inquiry** of any discipline, methodology is clearly defined and it is to be adhered to rigorously regardless of the problem or area of investigation to which it is applied" (1988, p.27).

This compiler must confess that he remains unable to form a clearly definitive opinion about the precise limits between **paradigm**, methodology, methodologies and **methods**.

2124

METRON ²⁾

"Unit of metrical **information** which supplies one **element** for a **pattern**" (D. McKAY, 1969, p.166).

Mac KAY comments: "Each **element** may be considered to represent one unit of evidence. Metrical **information** gives a **pattern** its weight or **density** – the stuff out of which the **structure** is formed.

"In a scientific **representation**, each metrical unit may be thought of associated with one elementary **event** of the sequence of physical **events** which the **pattern** represents" (Ibid.).

Each metron diminishes the quantitative **randomness** contained in the **variety** of possible **messages**.

Thus, while metrons are indispensable **elements**, only their ordered grouping produces a significant **pattern**. Metrons **interconnections** according to defined **rules**, are constitutive of **logons**.

2125

MILIEU¹⁾⁵⁾

The french word for **environment**, surroundings. This term has now been introduced in english by some authors.

2126

MIND³⁾

No definition!

The New American Heritage Dictionary – for example – gives 11 different definitions of “mind”, some of them quite difficult to compabilize with others. So, none is given here.

Systemists should make up their... mind about the *concept* of “mind”.

J.M. DELGADO, from his neurobiologist's viewpoint, writes: “The mind is an ill defined entity which usually is described as an active **process**. Most definitions indicate what the mind does, but not what it is or when and how it is formed. Basic mental **functions** are related to the reception, interpretation, **storage** and retrieval of both inner and outer **stimuli**. Some of these **functions** involve the **processes** of feeling, thinking, remembering, willing and other **phenomena**.”

“The **brain**, in contrast with the difficulties in defining the mind, is a well identified physical entity which can be seen, touched and weighted”.

Of course, this is impossible to do with a *working brain* within a skull in a living **organism**.

Besides, it is probably not the point. What is important in the **brain**, as the “producer” of “mind” is its **organization** and the **dynamics** of the cerebral **processes**.

The most that can be said about the so-called mind is to describe it as an abstract designation for a **set** of coordinated **brain** activities that can be investigated as physical **phenomena**. S. GROSSBERG, for instance, suggests that: “**Neural networks** that match sensory **inputs** with learned expectations help explain how humans see, hear, learn and recognize **information**” (1995, p.438-49). The mind is thus no concrete “entity” to be sought for.

The subject has also been deeply discussed by M. BUNGE (1979, p.124-185).

2127

MIND (Society of the)²⁾⁴⁾⁵⁾

A **model** of the **brain** as a vast **network** of **elements** (**neurons**) constantly and simultaneously interacting in multiple and varied ways.

This **model** has been elaborated by M. MINSKY (1986). It is closely related to von NEUMANN's initial work on **reliability** in **automata**; to Mc CULLOCH and PITTS's **neuron** model, to ROSENBLATT's **perceptron** (heavily criticized by MINSKY around 1960) and to MINSKY's own early work on a **neural network** model.

Curiously however, MINSKY manages to construct an impressive, but nearly completely abstract model of the “mind” without practically referring himself to nerves, and still less to **neurons**, which one should suppose to be the “agents” he invokes as the basic **elements** whose **interactions** lead to the **emergence** of the “mind” as an organized society.

Quite surprisingly, and except for quotes at the beginning of each chapter - mostly from novelists and philosophers unrelated to the subject - his book does not contain references to works by biologists, physiologists and neurologists. However it contains numerous figures and **graphs** that look like abstracted forms of **neural connections** and **paths** of **interactions**. At first sight, there is thus no incompatibility between his model and neuro-biological research of the last 50 years, of which one may surmise that he has a good knowledge.

The abstract character of his model may have been at least partly motivated by his belief that it would be possible to construct **computers** (made of interconnected and interactive **agents** - in this case electronic; and working in **parallel**), able to mimic higher cerebral and mental functions.

The model could also probably be used to study the “societies of minds”, i.e. interactive cooperative minds, which are a universal feature of human **groups** and in a near future, the massive planetary society of brains that seems to be now in the making.

K. BAUSCH gives an interesting synthesis of many of the foregoing opinions: “Mind emerges from relations among physical entities but is not itself a physical entity. It is an emergent constellation of **patterns** and **processes** generated through the interaction of **neurons** and the general transceiver functions of the **brain** in interaction with the **embedding holographic memory field**” (Glossary, pers. comm., 2002)

→ **Transputer**

2128

MINDBUGS^{1) - 3)}

Mental distortions that affect the ways people understand **situations** and issues.

This term has been recently introduced by J. WARFIELD, who “so far” identified four categories:

“**Mindbugs of Misinterpretation**: those where concepts are misconstrued or misattributed because of faulty interpretation;

“**Mindbugs of Clanthink**: those where concepts are widely perceived to be correct, but which are demonstrably incorrect;

“**Mindbugs of Habit**: those which involve ingrained **behavior**, evinced with essentially no conscious thought;

“**Mindbugs of Error**: just plain mistakes.

“A fifth category that is under consideration has been designed as “Mindbugs of Specific Human Shortcomings” This category is based on the hypothesis that there may be something inherent in people as people that causes mindbugs which can never be corrected” (1995, p.3).

Many of the 25 mindbugs hitherto identified by WARFIELD became manifest after the appearance of systemics and cybernetics. Others, of psychological and sociological origins, are obvious but were never explicitly acknowledged in a systematic way until now.

Some of the mindbugs listed to date:

- Affinity to all-encompassing **dichotomies**
- Indistinguished affinity to unstructured discussion
- Insensitivity to conceptual **scale**
- Misconstruing technology as science (and vice versa)
- Mistaken sense of **similarity**

WARFIELD even proposes a “mentomology”, as the discipline of the study of mindbugs!

For more details, see WARFIELD's reference.

→ **Blindspot**

2129

MINDSCAPES (Epistemological, Meta-types)^{3) - 4)}

The concept of mindscapes has been shaped by M. MARUYAMA from 1979 on (1979, p.13-23).

According to MARUYAMA, individuals as well as **cultures** differ from each other by very variable psychological and mental orientations.

In connection with **constructivist** psychology, sociology and **epistemology**, and with the **consensus** problem, universally present in every domain, MARUYAMA's typology classifies some of the causes of the innumerable difficulties, misunderstandings, and **conflicts** which afflict humanity.

The four basic types described by MARUYAMA are as follows:

- (1) H-type: **homogeneistic**, **hierarchical**, classificational.
- (2) I-type: **heterogeneistic**, isolationistic, **random**.
- (3) S-type: **heterogeinistic**, **interactive**, **homeostatic**.
- (4) G-type: **heterogeneistic**, **interactive**, **morphogenetic**.

MARUYAMA gives numerous examples. According to him:

“Let us keep in mind there are other types, as well as mixtures of types... In any large society or **culture**, it is possible to find all four and many other types in individuals. The types are partly innate and partly learned. Different **cultures** and professions exercise different pressures for or against some types in the **process** of acculturation, socialization, ostracism, marginalization, etc. Individuals also exercise self-selection, internalization, sublimation, attrition,

alienation, repression, **identification**, etc. It is possible for an individual to change his/her type, but there seems to be a critical age, after which it becomes very difficult to change types. There are individual variations in the age limit as well as in the degree of difficulty. Some individuals become fixed in childhood. Others may be able to change much later in life.

"The mindscape theory may appear to be a typology. However, its purpose and use lie in interrelating seemingly separate aspects of human activities such as **organizational structure**, policy formulation, decision **process**, **management method**, architectural **design**, **criteria** of beauty, **choice** of theories, etc. It is relational rather than classificational" (Ibid).

MARUYAMA seems to view himself as belonging to the G-type. He uses his theory as an orientative guideline for non-authoritarian teaching, that should be "**morphogenetic**", i.e. open to **creativity**.

He applied it more recently to "Mindscapes in **management**" (1994), particularly considering the psychological and cultural problems of expatriate executive officers in multinational enterprises.

2130

MINIATURIZATION¹⁾

The evolutive replacement of **components** in systems by smaller ones.

H.T. ODUM observes such an **evolution** in many mechanical and electronic systems. He believes that the same trend exists in biological systems and writes: "Miniaturization provides more **function** for less power and less **space**, ultimately allowing more **function** and **complexity** for the same **resources**" (1971, p.158).

The trend toward miniaturization could gather new impetus through the use of **self-assembling** materials at microscopic level.

Miniaturization will offer a selective advantage to small **components** and **machines**. However, it also will soon or later reach its limits, even in electronics (See: "The end of the line", The Economist, Nr.7923, June 15th., 1995).

2131

MINIMAL PRINCIPLES^{1) - 2)}

J.H. MILSUM found that: "A number of minimal principles, that is, equivalently **optimality** principles, are recognized in physics". Examples offered are FERMAT's Principles of least **time** propagation of light in media of different refractive indices; MAUPERTUIS's Principle of **Least Action**, and the "most general minimal principle of physics called HAMILTON's Principle".

MILSUM proposes "A generalized verbal formulation of such principles ... as follows: The particular solution "selected" by a **process** in a physical system will be that one out of the possible family of solutions, all consistent with given **constraints**, which minimizes a certain "**cost**" (1968, p.46).

MILSUM proceeds with this comment, very basic from a systemic viewpoint: "The major drawback to universal application is that only conservative systems can be so treated" This is a result of "the ubiquity of **dissipative phenomena**" (Ibid).

The validity of any minimal principle is thus conditioned by the existence of **steady-states thermodynamics**, but ceases in **far-from-equilibrium** conditions.

2132

MINIMAX STRATEGY²⁾

An **operation research method** which "computes the maximum risk and then selects the **strategy** which minimizes this" (1968, p.209).

This **strategy** is a result of J.von NEUMANN **minimax** theorem, according to which, between two players "the maximum of one's minimum is the minimum of the other's maximum" (D. RUELE, 1991, p.52).

von NEUMANN demonstrated his theorem in 1928. It became the bedrock of the Theory of **Games**, fully developed by him and Oskar MORGENSTERN in their 1944 book "The Theory of Games and Economic **Behavior**"

2133

MINIMIZATION ALGORITHM (Adaptive)²⁾

An algorithm that schedules different hints for **learning** in a way that achieves a balance among them and with the training **set**.

Y.S. ABU MUSTAFA, who introduces the concept, writes: "The A.M.A. is adaptive in the sense that it constantly evaluates how well the **machine** is satisfying both the hints and the training examples, and continually modifies the adjustable **parameters**"

The term "minimization" "reflects that the **algorithms** is trying to minimize a quantitative measure of the **error** between the current actions of the **machine** and the **behavior** ultimately desired for it" (1995, p.73).

This concept could possibly be extended to the study of **natural learning networks**. Markets, for example, seem to search in an adaptive way for **dynamic equilibrium**.

The difficulty is to understand and interpret the **behavior** of participants in a self-organizing A.M.A.

2134

MINIMUM (Law of)^{1) - 2)}

"The **stability** of the **whole** depends on the least relative resistances of all of its **parts** at any moment of **time**" (A. BOGDANOV, 1980, p.91).

This 1921 proposition by BOGDANOV is only one of many, but it emphasizes the systemic and the dynamic character of the law.

2135

MINUS-ONE EFFECTS₋

→ See hereafter

2136

MINUS-ONE METHOD²⁾

A way to study the **role** of some **part** in a **whole** by removing that part and observe the result in the system as a whole.

This is a very general method that can be applied to any kind of system, whether biological, ecological, social or mechanical.

The minus-one effects are either specific and, or local; or on the contrary destructive. Let us remember that battle that was lost for want of a horse-shoe.

In some cases, a very minor minus-one effect can act as a **trigger** and may have enormous consequences, particularly in **ecosystems**.

2137

MITWELT¹⁾⁽⁴⁾⁽⁵⁾

A german word whose **meaning** is co-world, i.e. the **environment** with which we are interdependent.

The term would usefully replace the "**Umwelt**" concept, at least for **human system**. In fact, most people see our Umwelt merely as the background that humans can exploit and use at their own convenience, feeling as they were "bosses" of nature, in an unlimited way (ECIMOVIĆ, T. et al., 2002, 1.4)

Contrarywise, "Mitwelt" clearly indicates that the **relationship** is reciprocal: people act and react with their specific environment in various distinct way:

- they must adapt to the nature of the environment: there are for example "desert cultures", islands cultures', arctic cultures"
- they must adapt and readapt to the natural variations of their environment
- they receive **feedbacks** from their **action** on the environment and must adapt to the consequences of these feedbacks

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

All this means moreover that the **interdependence** is a dynamic constantly ongoing and ever variable **process**

→ **Co-evolution; Control; Ecosphere; Eco-systems dynamics; Effects (Delayed); Effects (Side); Parasitism; Regulation; Symbiosis; World engine**

2138

MIXING²⁾

The characteristic "... **behavior** of a system such that any particular **configuration** can be reached from any other one" (R. FIVAZ, 1991, p.32).

This seems to be a quite exceptional characteristic in systems.

2139

MODALITY³⁾

A definite **level** in a **classification** of **levels** of **action**.

A theory of modalities has been introduced by H. DOOYEWEERD, as quoted by D.DE RAADT (1992, p.639). There are 15 **levels** in DOOYEWEERD's **classification** (which like any **classification** is debatable), starting from the "harder" to the "softer": numeric, spatial, kinematic, physical, biotic, sensitive, analytic, historic, lingual, social, economic, aesthetic, juridical, ethical and pistic (religious belief).

Starting from DOOYEWEERD's proposal, D.DE RAADT introduces "**multi-modal thinking**", an "essentially **non-reductionistic**" approach, which "assumes that for each of the fifteen modalities there is a corresponding **epistemology** which cannot be supplanted by and is as worthy as the **epistemology** of another modality... In themselves, no single **epistemology** is sufficient for a complete **knowledge** of the universe, but each contributes to a distinct outlook which, when merged with the others, give rise to a multi-modal thinking that discerns an **object** from every modal angle, leading to a coherent and wise **understanding** of the **object**" (Ibid).

Starting from this base, DE RAADT proposes "**multi-modal design**", which, for any system, starts by defining the various modal **levels** of interest, specifies the basic one and leads to an integrative study.

2140

MODE^{2) - 5)}

1. A specified **pattern** of **periodic** or vibratory movement.

Simple **oscillators** have only one mode of **periodicity**.

Modes are related to **frequencies** in **oscillations**.

D. RUELE writes: "If only one mode is excited, we observe **periodic oscillations**. If various modes are excited, the fluid's movement becomes irregular and, when many modes are excited it becomes **turbulent**" (1991, p.71).

In general, **turbulence** implies **chaotic determinism**.

2. The value occurring most frequently in a series of statistical **observations**, or probability **distribution**.

A **distribution** may present two or more very frequent occurrences. It is then called bi- or multi-modal. This may be the case for instance in **Markov chains** or **Markovian systems** and correspond to various preferred **states**, for example in a **population distribution**. This was interestingly developed by W.R. ASHBY (1956, p.166-7 and 225-29).

2141

MODEL^{2) - 3)}

"A **symbolic representation** of a **set** of **objects**, their **relationships** and their allowable motions" (P. DENNING, 1990, p.466).

DENNING explains: "We use models in three principal ways:

"**Description**: we sometimes use a model to describe how a system works. Examples are a blueprint, a **scale** model of a railroad, the equation of motion of a planet, the scientific method, and the software-**design process**.

"**Computation**: We sometimes use a model to guide, to reproduce or to calculate action in the **domain**. Examples are following directions from an inertial guidance system (guiding), a flight simulator (reproducing), or computing a **measurement** (calculating).

"**Prediction**: We sometimes use a model to predict the future **state** of a system with tolerable certainty. Examples are the models that predict the lift of a wing in flight, the position of a star or the future **state** of the weather or the world economy. A model is useful for **prediction** only if the future **state** can be calculated much more rapidly than in real **time**, and only if its users agree that the assumptions about **parameter** values and governing laws will hold at the future **time**."

This author adds: "Models are of interest because of our unavoidable concern to anticipate and prepare for future **action**, and because they make the world seem simpler and more understandable" (p.466).

B. ZEIGLER observes that a model that "could correctly answer every conceivable question about a real system... is not realistically constructable for large **scale** systems. Indeed, we assume that with every large **scale** system there is associated a multitude of models capable of answering only a limited **set** of questions about the real system with any degree of credibility" (1978, p.81).

T.F.H. ALLEN and T.B. STARR use another definition for model: "An intellectual **construct** for organizing experience" (1982, p.273).

J. CASTI puts it as follows: "The scientific answer to a question is a **set of rules**, or as such **rules** are more commonly termed, a model" (1994, p.4). If this is the case, specific models are mere products of more general conceptual **constructs**... or possibly is it the other way around!

ALLEN and STARR also observe: "We generally do not extend our use of the word to include models as approximations of **ontological** reality. We prefer to acknowledge that we do not know what is the **relationship** of models to **ontological** reality" (Ibid).

→ **Ontological skepticism**

2142

MODEL: A semantic muddle³⁾

In her paper on "Models and retroductive inference", M. ESTEP explores "some of the broad **categories** of the concept of "model" in scientific inquiry" (1992, p.585).

She states: "Clearly, some in the systems science **community** would use "**theory**" and "model" as equivalent. Others have taken a more qualified position, that is that models are "embryonic **theories**" and **theories** are "generalized full-term models" (See next heading) (W. ACAR, 1988, p.172).

According to M. ESTEP, however, "All models and **theories** are "abstract" and "concrete" to some degree".

The **distinction** is still quite obscure: it would seem that any first **level** model is a **homomorphic representation** of some "**object**" (with all the **ambiguities** associated with this term). Further on, collections of more or less **isomorphic** models may appear and allow for the construction of more abstract and general models (in a gradation explained by KORZYBSKI through his **structural differential**). A **set** of abstract models, satisfactorily interconnected within a logical and more global **frame**, could indeed be called a **theory**, as defined by M. ESTEP: "A system of statements which are conjectures characterizing **objects**"...

In any case, **theories** are farther away from **objects** than models are, and reflects quite more our basic mental **structures** and **mind-scapes**.

2143

MODEL (Formal System)

→ **Formal System Model**

2144

MODEL (Generic and Concrete)²⁾

J. ARACIL proposes the following distinction between "generic" and "concrete" model, in order "to clarify some **ambiguity** in the ordinary use of the term model":

"When one speaks currently about models there is some vagueness that is convenient to analyze... On the one hand, one speaks of a model without specifying the numerical values of the **parameters**. In this case we use the term "model" with the meaning of "generic model M". Giving values to the parameters we have a "concrete model C". This is the second meaning of the word model" (1979, p.245).

One of the most demanding challenge to be met by systems science, is to produce generic models which can in turn be used as **matrixes** of concrete models for practical applications.

ARACIL's generalization of FORRESTER's **systems dynamics** by use of **attractors** in order to generate qualitative **bifurcations** in the **modeling process** is certainly an important step toward this goal.

2145

MODEL (Implicit)

→ Knowledge (Implicit)

2146

MODEL (Observer's)³⁾

Any model is necessarily an observer's model. Only **living systems** construct models, as a device for **survival** and only humans construct very intricate models. G.A. & D. MIRHAM make the point: "**Modelling** is the very activity of Nature by which **survival** of Life on Earth is accomplished and assured" (1978, p.134).

R HARDEN states:

"From the prospective of the observer a model might be described as operating in one of two distinct ways:

1) The model may be held to represent or convey a "objective" **state** of affairs (e.g., as the model engine is held to "point at" a real locomotive or the model of DNA is sometimes described as reflecting the genetic **code**). As such, any one model will be understood as true or false if "neutrally" conveying a picture of such "reality".

2) The model might be described as enabling the orchestration of diverse viewpoints, in a **process** that brings forth some **consensually** accepted version of reality for a **community** of observers" (1990, p.291).

The **consensual** model does not negate the existence "out there" of "reality". It only states that this reality is "veiled" (to use B. d'ESPAGNAT's very apt term, 1985), because of our **physiological limits to perceptions** (sensorial and neurological), as observers.

We may admit its validity if we admit a sufficient **convergence** in our own personal ways to perceive and to obtain internal **representations** of some **situation**.

The "engine-type" model could be called hard, because **consensus** is so easy and generally stable (as it refers to man-made or quite common natural "**objects**"), that its existence is not even perceived.

The **consensus** model is a soft one, because it refers to complex **situations** whose observation produces easily ambiguous evaluations.

In any case "we communicate only through models" (G. BATESON). So is it also when we communicate, whatever we want to achieve.

2147

MODEL (Predictive)²⁾

A model whose **dynamic** features lead to, or aim at **forecasting**.

Predictive models are the first condition for the institution of **anticipatory behavior** through **feed-forward** (R. ROSEN, 1991, p.543-4).

ROSEN observes that even biological **organisms** seem to possess some nonconscious **behavioral** traits akin to predictive models, based on the **present observation** or registration of some sequence of **events** that can be interpreted as **early warnings** of future **events**: A deciduous tree sheds its leaves not *because* the winter is coming, but because it registered the recent **trend** of the days to shorten. In such cases, some very general hereditary genetic **trigger** must be present.

ROSEN is in fact quite careful and states: "*In any law governing a natural system, it is forbidden to allow present change of states to depend upon future states*" (p.545, italics his).

See "**teleological explanations**" and "**System (Anticipatory)**".

2148

MODEL (Prescriptive)²⁾

A model that can be used "to prescribe **operations** by which a conceived man-made **object** can be built" (G. KLIR, 1991, p.84).

KLIR states that: "The construction of prescriptive models... is usually referred to as **systems design**" (p.84). This is true, but unfortunate, because this bonafide engineering terminology has been extended to the **design of human systems** and, in not a few cases, contaminated this latter endeavor with restrictive **mechanistic** views.

KLIR explains in a detailed way the two principal stages of the construction of a prescriptive model:

"The aim of the first stage is to formulate the **design** problem on the basis of the conceived **object** to be designed...

"The second stage... consists in constructing a system that implements the required **relations** in terms of the interpreted systems representing the chosen technological primitives and which satisfies the required objective **criteria** and **constraints**" (p.84-5).

A good example of such a **process** would be the progression from the general idea of a new type of car, to the precise blueprints, the planning of retooling, adaptation of the production line and generally related organizational conditions.

2149

MODEL – REGULATOR IDENTITY (Law of requisite)^{2) – 3)}

"Any **regulator** that is maximally both successful and simple must be **isomorphic** with the system being regulated" (R.C. CONANT and W.R. ASHBY, 1970, p.89).

The authors made various interesting comments:

1) Models can be unnecessarily complex.

2) The search for the best **regulator** is essentially a search among the **mappings** from S into R.

3) The proof of the theorem avoids all mentions of **inputs** (an aspect correlated to the **autopoiesis** concept).

4) A **time-varying** model could be needed if the **regulation** is to be **time-varying**.

5) To those who study the **brain**, the theorem founds a "theoretical neurology": "There can no longer be question about *whether* the **brain** models its **environment**: it must" (p.96-97).

Another interesting line should be looking for social regulators (**Values? Norms?**), their degree of **isomorphy** to the social system and their eventual **time-variance**.

2150

MODEL (Retrodictive)²⁾

A model whose use allows the rediscovery of past **states** of the system, with a reasonable degree of **reliability**.

A good retrodictive model, just as a predictive one, depends on the existence of a reliable **knowledge** of the **dynamics** of the system and its **environmental** conditions, normally to be obtained by **inference** from sufficient **data** during a sufficient lapse of **time**. (But, how does one makes sure of what is "sufficient"?).

All in all, retrodiction supposes a well defined basic **deterministic** hypothesis. If the system is **ergodic**, or still worse, **chaotic**, precise retrodiction is impossible.

2151

MODEL (State determined)²⁾

"A model whose future states may be ascertained solely from **information** regarding past **states**" (T.F.H. ALLEN & T.B. STARR, 1982, p.278).

2152

MODEL (Structure of a)²⁾

The **set** of the model's "**components**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

D. MEADOWS et al. thus describe in fact, the **structure** of a **computer model**. They comment: "... one should be careful to distinguish, when discussing a model, whether or not one is talking about the **structure** of the model or that of the real system" (Ibid).

... That is, if one is mentally prepared to perceive the difference.

2153

MODEL (Symbolic system)¹⁾²⁾

"The description of a conceptual system model (CSM) in a natural or formal **language**" (E. VACCARI & M. D'AMATO, 2000, p. 170)

"A symbolic system model is a **representation** which involves what is represented, the representation and the **modellers** i.e. the user of the representation" (Ibid)

The real problem is of course the representation one.

The authors discuss the computational approach and the biomimetic approach, through "**animats**" (artificial animal-like robots). Here, the question mark is: up to which point do we understand living beings **behavior**- and especially intelligent behavior- and reproduce it in "**animats**".

2154

MODEL ACCURACY²⁾

H.C. GAUCH writes: "Many researchers believe that a model can be no more accurate than the **data** it uses. But is this so? The answer depends on three matters: the precise question being asked of the model; the **design** of the experiment and the quantity and accuracy of the available **data**".

GAUCH gives the example of the MENDEL genetic experiences: "When he combined his **data** from all seven experiments, he found a ratio of 2,98:1 for the dominant and recessive traits. He modeled this as a 3:1 ratio, which also explained and predicted other experimental results" (1993, p.468). GAUCH concludes that "a model can be more accurate than the **data** used to build it because it amplifies hidden **patterns** and discards unwanted **noise**".

This is a very interesting feature, quite important for systemics. It should however be taken with care: discarding "unwanted" **noise** could lead to fudging.

2155

MODEL AND THEORY^{2) - 3)}

M. SIRGY and W. ACAR debate in the following terms the differences of "model" and "theory".

SIRGY writes (1988, p. 171): "A model is a conceptual tool that postulates a **set of relationships** between concepts for the main purpose of controlling a given **phenomenon** from which prediction serves the controlling **function**. A theory on the other hand, is a concep-

tual tool that postulates a set of **relationships** between/among concepts for the main purpose of explaining a given **phenomenon** from which prediction falls out the explanatory **function**".

According to SIRGY, basic scientists tend to use theories more than models. They are more interested in explanation than in **control**, while applied scientists more readily apply models for the opposite reason.

ACAR, on the other hand, describes "theories... as deductive systems" (ACKOFF) and argues that a model is "an embryonic theory", while a theory is generalized full-term model". He understands that the model is embryonic because:

- its **language** is generally borrowed and is seldom tailor-made
- its underlying assumptions may not yet have fully surfaced
- its underlying logic may still be in the making
- its propositions are still being explored and probably have not reached theorem status yet
- not all its implications have yet been understood (1988, p. 173).

Eventually, a much worked out model or a family of models may lead to a theory.

2156

MODEL as a system (The)^{2) - 3)}

P. DENNING writes: "...the model is itself a system that has **variables**, **parameters** and **loops**. It is possible to offer a simple model for a complex **domain**, although we would be surprised if the model were **reliable** in this case" (1990, p.497).

Basically, the model would need to be **isomorphic** to the modeled system. However, as modeling implies simplification, **isomorphies** eliminate too many characteristics, and we are left with **homomorphies**. But, at least, there should be a **minimum of structural and dynamical** correspondance between the system and its model.

In fact, as stated by K. KRIPPENDORFF, a model: "a) embodies a theory of that portion of reality which it claims to represent or b) corresponds to a portion of reality by virtue of an explicit **homomorphism** or **isomorphism** between the model's **parameters** and given **data**" (1986, p.50).

2157

MODEL BUILDING^{2) - 3)}

"A **strategy** by which a conceptual **representation** of a system... is constructed and from which specified outcomes can be determined" (B. BANATHY, 1973, p.87)

This definition by B. BANATHY shows that model building is not a *neutral* activity. Any **representation** is constructed at a specific **hierarchical level**:

1. on the base of **data** collected with a specific intention, hoping that they are correct and adequate.
2. from a specific viewpoint depending on the intention, need or **goal** of the modeler;
3. on the base of the general conceptual **frame of reference** that dominates the mind of the modeler.

The same point has been made by E. JANTSCH: "Model building is essentially a creative or inductive **activity** by which we are building a generalized system out of **elements** of our **consciousness** - though not just of **observations** and rational **knowledge**, as science would have it... Models and myths are inextricably interwoven; what is conceived as a model in one direction becomes a myth in the other, and governs as such the building of new models. So closely interdependent are the two parts of the **feedback process** that we may call them a short-circuit within man's **mind**. If this sounds alarming, it *is* alarming. Of all the traps built into man's cybernetic existence, the model/myth **loop** is the most difficult vicious circle to break out of" (1975, p.191-92).

Other **filters**, not always perceived, do limit the modelizer's **activity**, as shown by St. BEER (1968, p.113-115), M. MARUYAMA (1985, 1994) and other authors:

- **perceptions** are influenced by mental, psychological, cultural and even sometimes physiological limitations or biases;
- when mathematically formalized, the model also depends on the mathematical tools used;
- dynamic **situations** cannot be exclusively represented by **static** models.

More precisely, any model building depends on complex perceptive and mental **processes** whose principal steps are:

1a) **Perception (physiological):**

direct: through our senses

We remain perceptually framed within the **limits** of our physiological capacity to register and assimilate **events**.

indirect: through some **artefact**

Our **artefacts** are supposed to transmit us correctly the **structure** and **processes** that we observe, i.e. without (eventually unknown) deformation produced by the **artefact**.

1b) **Perception (psychological):**

We perceive, at least up to a point, according to our accumulated former training or recordings, and our beliefs.

1c) **Perception (social):**

We tend to conform to what is expected from us. This may easily lead us, for example, to give or receive unreliable testimonies.

2) **Conceptualization:**

Our way to build a mental **representation** of what we perceived depends on our formerly accumulated **knowledge**. Any such **representation** is necessarily constructed in relation to preexisting conceptual **frames of reference** as for example our personal or specific **mathematical knowledge**.

3) Modelization proper:

We construct our models "ad hoc"; having in mind some **purpose**. Thus, we may select a specific model out of various possible ones, because we want to change in some definite way the concrete **process** or system so modeled.

→ **Surrogate world**

2158

MODEL BUILDING (Iterative process in)^{2) - 3)}

Obviously, when a model is put to practical use, its **reliability** is frequently doubtful.

The **modeler** should always be aware of the limits of the model's **validity** and, in consequence, revalidate it frequently: we should remember St. BEER warnings about the "surrogate world we manage" (1973).

Unfortunately, **modelers**, in many cases, do not recognize discrepancies and perturb heavily the *concrete process or system* by taking erroneous **decisions** and stick to them, even against strong evidence.

To avoid this, **modelization** should be iterative, as advocated by St. BEER. This is stated by J. ARACIL as follows: "The **mechanism** underlying the model should be frequently reviewed throughout the modeling **process**. These revisions are made in such a way that the successive models progressively fit in with the modeled **object**. The building up of a model is an **iterative process** where successive theoretical frameworks (normally re-elaborations of former ones) are adapted" (1986, p.243).

As a synthesis, **iterative** construction of models is a cybernetic **process** based on mental **feedback**.

2159

MODEL (Computer)^{3) - 5)}

D. MEADOWS et al describe as follows the main qualities of computer models:

"**Rigour**: The assumptions in computer models must be expressed completely and precisely; no **ambiguities** are possible... (while) Mental models are usually fraught with inconsistencies...

"**Accessibility**: Because all assumptions must be written out in order to communicate them to the computer, critics can examine, assess, and alter computer models. Mental models are unexaminable and uncriticizable; their assumptions are not even entirely clear to the **modellers**.

"**Comprehensiveness**: A computer model can contain much more **information** than any single mental model and can keep track of many more **interrelations** at one time.

"**Logic**: If programmed correctly, the computer can process even a very complicated **set** of assumptions to draw error-free conclusions... Different people may agree completely about a **set** of assumptions and still fight about the conclusions to be drawn from them, if they have only mental models to rely on.

"**Flexibility**: Computer models can test a wide variety of conditions and policies (which is)... much less costly and time consuming than tests in the real world. Different assumptions can be tested more easily and openly than they could be in a single mental model" (1982, p.12-13).

→ Assumptions Analysis

The same authors recognize however that: "Those are *potential* advantages of computer modelling over mental models, but they are by no means always realized. Computer models can become so supercomplex and be expressed in such esoteric jargon that they are less open to critical **evaluation** than mental models. They are not logical **error** free if they contain undetected **errors** in **programming**, typing or interpretation. They are not more comprehensive than mental models if their mathematical properties require the omission of things that non-mathematical people know to be important. They cannot provide easy tests if each run requires several thousand dollars, several days of computer time, six months of **preprogramming** and postprocessing. Computer modelling techniques are also based on deep, unexpressed, technical **paradigmatic** assumptions that are not congruent with mental models and often **constrain** what can be included" (Ibid).

The most important of these **constraints** are probably the need to use **binary logic** in the modelling **process** and the impossibility to take care of *simultaneous change* and thus of the **sensibility** to multiple **initial conditions**, proper to **complex systems**.

As a result, computer modelling, when applied to highly **nonlinear** global problems as in the various **Club of Rome world models**, are prone to many difficult problems and controversial interpretations.

For a critique of "acts of faith that regularly appear in global models" and their computer representation, see the same authors (p.285). Their deeply felt honesty is to be commended.

2160

MODEL (Concept of)^{2) - 3)}

The concept of model has been widely discussed by a number of prominent systemists. Here are some relevant comments:

1. by John WARFIELD (1987, p.229)

"I believe that the word "system" should be reserved for something that is "out there", and the word "model" should be used for whatever human constructions we happen to use as a surrogate for the system. Another advantage of this is that the concept of system always remains open to amendments as more is learned, which is an inherent requirement for scientific advance. And the amendment can be made to the model as required.

"Even the word "model" has been co-opted in effect by people who insist on **underconceptualizing** it to the point where many people interpret the term to be congruent with a set of differential equations or their quantized surrogate, instead of its more general interpretations as a human **construct** applied to describe some **phenomenon**."

2. The same point is made by D. MEADOWS et al: "All human **decisions** are based on generalizations or **abstractions** about the world, or models. Most of these models exist only in people's heads. We call them mental models... complex, shifting and often un verbalized" (1982, p.XIX).

3. For V. TURCHIN a model is basically a "generator of **predictions**": "Informally, a model of a **process** is another **process** which somehow mimics, or simulates, the primary **process**; thus by using a model it becomes possible to know something about the modeled **process** without actually running it, or predict developments before they actually happen" (1993, p.6)... which is all right, provided the model is reasonably accurate... and not too cumbersome.

In other words, let us not confuse some of the numerous specific, and quite restricted type of models with the general concept of model. See in this sense the taxonomy of models established by P. VOLTES BOU and B. WALLISER. (hereafter)

2161

MODEL (Conceptual system)²⁾

"A system perceived as a unit by an **observer** (i.e. the modeller)" (E. VACCARI & H. D'AMATO, 2000, p. 170)

"In general a **modeller** formulates a CSM for some specific **purpose** which determines the aspect (i.e. **selection** of specific significant **attributes** among the infinity of potentially distinguishable ones) or the **process** (i.e. **time function relations** between **attributes**) to conceptualise" (Ibid)

However, there are doubts about the practical use of the CSM when translated to a computational **method**.

The authors state that "basic metaphysical **assumptions** underlying the computational approach are the existence of a **language** of thoughts (FODOR, 1975) and the independence (based on the notion of computational equivalence) of a **cognitive process** performance from the medium carrying on the process itself.

The approach is based on the assumed similarity between the mind and a universal **Turing machine** (NEWELL, SHAW and SIMON, 1958) from which the notion of a physical **symbol** system as an **information** processing device has been derived.

A physical symbol system necessary and sufficient to produce intelligent **behavior** (NEWELL & SIMON, 1976) is a **set** of physical **patterns/discrete symbol** strings and a set of explicit **rules**. The rules can also be coded as **symbolic structures** and they describe how to manipulate the symbols" (ibid)

This seems in fact to be a quite simplistic linear and somehow nearly mechanistic view, very different from the nature of **neuronal net activity** in the brain (i.e. multisimultaneous processing, with **reinforcements**, dampenings, **parallel distributed processing**)

In fact, the classical computational approach evacuates the real **complexity** of modelled systems. This is why conventional **artificial intelligence** does not seem so "intelligent", after all.

2162

MODEL (Continuous or discrete)^{1) - 2)}

Formal or mathematical models can be continuous or discrete. Historically, continuous models based on differential equations have been the accepted **methodology** for modeling in science.

However, since the development of **digital** computing, "discrete models are influencing our conception of real world systems and the role classical mathematical **methods** are to play in modelling them" and: "In many applications of these discrete concepts the availability of theoretical results is replaced by the computational power of **digital computers**" (A.G. BARTO, 1978, or in G. KLIR (ed), 1991.p. 377).

Computers, becoming a kind of experimental laboratory tool, and being **digital**, offer (and require) a new **class** of models, frequently called "**simulations**". This offers at the same time, new **variety** and new **constraints** to **modelization**. BARTO, after a careful discussion, concludes that: "... computational power **alone** is not a substitute for the careful simplification and theoretical generalization that have helped make classical **methods** so fruitful" (p.395).

This clearly is a more polite, but still powerful caveat carrying the same **meaning** as the famous "Garbage in, garbage out".

In any case, both type of models are useful in their own right. Neither, however, tell us the ultimate "**truth**" about reality.

It is also possible that **connection machines** will introduce still another type of models in the future.

→ **Modelization by computer (Limits of)**

2163

MODEL MAKING¹⁾²⁾³⁾

Model making is possibly the most universal and basic mental **activity** of all people. Even superior animals probably elaborate some types of models of their **environment**.

We absolutely need models for our general orientation in life and as a bedrock for **behavior**.

They seem in fact indispensable for our very **survival**.

However a serious reflection about our ways to elaborate models, and even what we mean exactly by "model" is a very recent development. Still now most people make models in a quite naive way.

This is so because scientifically based models need considerable abstract **knowledge**, a fact that would block that basic activity for most people and put them at a loss, or even in danger.

However naive model making frequently leads to dramatically negative results for **communities** as well as for individuals.

A better **understanding** of our model making ability (or incompetence) is one of the most important result of various developments in cybernetics and systemics, among them:

- Autopoiesis (MATURANA y VARELA)
- 2nd Order cybernetics (von FOERSTER)
- Constructivism (von GLASERSFELD)
- Generic Design (WARFIELD)
- Co-participative Design (BANATHY)
- Genetic psychology (PIAGET)
- Gestalt psychology (WERTHEIMER, KOHLER and KOFFKA)
- Metamodeling (van GIGCH)
- Operational research (BLACKETT, ACKOFF)
- Systems dynamics (FORRESTER)

and of course a wide variety of more limited and specific techniques that have also been proposed (See the corresponding entries)

2164

MODEL TRANSFERABILITY^{2) - 3)}

The possibility to generalize a particular model in order to use it in a **variety** of cases.

P.M. ALLEN et al. propose the following – quite systemic – way to construct general models: "Instead of building a model of a particular system (New York, the insurance market in Belgium, the Aleutian ecosystem) in terms of the salient features of the moment, it may be more informative to study generic models (urban systems, markets, interacting **populations**...) and the ways that their constituent **elements** cluster, grow, and structure according to the series of "folds" that their **interactive mechanisms** impart to them, and the **attributes** which emerge for different branches of solutions.

"The study of such evolutionary trees may then show us that New York, Brussels, and other cities correspond to different branches of solution of **similar** models with different **parameter values** and different histories. Only a "transferable" model of this kind can be used predictively on a particular case, since a model built in terms of a particular problem, and calibrated on it, is a purely descriptive **construct** incapable of anticipating **change**. So,... a good model must be a **metamodel**!" (1985, p.76).

... Or at least derived of such a general frame in accordance with the specific situation under study.

And the best **metamodels** are those which retrace **analogies**, **homomorphies** and **isomorphies**.

2165

MODEL VALIDATION

→ **Validation (Model)**

2166

MODELER (Role of the)¹⁾

The role of the modeler should not be merely technical. Even if his/her **models** refer to quite simple **processes**, as for example **queuing**, he/she should at least seek **information** about the system within which **queuing** occurs, as for example in which conditions, when and for which reasons it occurs. Only then may the **model** be really understandable and useful to the **decision maker**.

It must however be conceded that the dialogue between the modeler and the **decision maker** is often awkward. Both could in many case benefit from the **systems approach**.

Modeling also implies **processes** of simplification and **abstraction** that should not remain merely implicit or hidden. In particular, sequential **modeling** in computers implies a certain **concept of causality** which may not take care of real **complexity** resulting from the different **rates** of propagation in **time** of the various interacting **initial conditions**. This problem is quite obvious in FORRESTER's **systems dynamics**.

On the other hand, no modeler is free of biases and, in D. MEADOWS et al.: "One can never be fully aware of all one's biases. But one can be aware that one is unaware and deliberately expose oneself to **situations** in which biases can be discovered (the best way is to 'hang out' with whomever one regards as the enemy). In the presence of all global modelers, the special preferences and phobias of each different global modeler become evident. Giving the thorough agreement that modeling is not and can never be a detached, totally objective **activity**, it would be a refreshing change to see modelers present themselves in person and in print as involved human beings instead of detached, objective mechanics" (1982,

p.278-9). These questions have also been considered, along with the subject of moral responsibility of the modeler, by F. KILE and A. RABEHI in their paper on "The Agenda of the Modeler" (1979, p.18-24).

2167

MODELING and METAMODELING²⁾ - 3)

J van GIGCH emphasizes the important distinction between modeling and metamodeling: "Modeling... implies that the **modeler** "abstracts" properties from things in order to obtain a **representation** of the physical world. It is easy to conceptualize that the **model** stands at a **level of abstraction** higher than the things from which the properties are obtained. The **process of abstraction** can be applied to modeling itself, to obtain a **model** of the modeling **process** which we call a **metamodel**.

"The **metamodel** embodies the properties which are abstracted from all **models** (There is more than one **model**). By metamodeling we imply a **process of design** which is carried out at the **metalevel**, and by which we define how the **process of modeling** (at the **object level of abstraction**), is to be carried out. **METAMODELING** defines the **epistemology** or **design** foundations of modeling. **Design** foundations consist of the reasoning **processes**, guarantees of **truth**, proofs, axioms of validity, or any other logic which underlies a **methodology**.

"Any discussion of modeling must, of necessity, involve metamodeling from which the former evolved" (1992, p.2-3).

If it does not involve it explicitly, it does it in an implicate – if not more or less unconscious – way. This can be risky, because:

- hidden **epistemological** assumptions may be unsound
- they may even be perfectly sound in the **modeler's** view, but not admitted by all **stakeholders**. This may remain unknown if the **metamodel** is not openly discussed.

This is still more important at the **meta-metamodeling level**, where **values** are paramount.

This "ladder" for **validation** is related to **GÖDEL's Theorem**, as shown by Ch. FRANÇOIS (1987), as well as with KORZYBSKI'S **structural differential**.

2168

MODELING (Interpretive Structural)²⁾

A **methodology** "used to enable the participant **group** to develop logical **patterns (structures)** of **relationships** among concepts produced by **Nominal Group Technique**" (J. WARFIELD, 1989, p.2).

The aim of this modeling technique is to limit as much as possible what WARFIELD calls "**Underconceptualization**" which includes remaining stuck in a too limited conceptual

frame; rationalizing so-called "problems" (which are generally "human **constructs** not subject to **observation**"; and shrinking **design** by limiting it to restrictive **contexts** (p.9 -10).

According to WARFIELD: "It is a powerful **learning method**, because it involves disciplined, detailed, examination of **relationships** among factors involved in the complex issue; accompanied by discussion and further clarification".

"The **patterns** produced by the use of this **methodology** can take any **variety** of forms. However a very common form of **pattern** that is produced is called a "**problematique**". This particular **pattern** shows how a **set of problems** all involved in the **issue** are interrelated to each other in an influence **pattern**. Specifically, such a **pattern** shows how a given problem may cause some other problems in the **set** to become worse. **Problematiques** typically contain "cycles"; i.e. **subsets** of problems such that each problem in the **subset** makes every other problem in the **subset** worse. Cycles represent (model) escalating **situations** that may only be susceptible of corrective **action** by working with all the members of the cycle as a **group**, rather than working individually and independently with problems, uninformed by their **interaction**" (1991, p.199).

2169

MODELING (Interpretive structural)

→ Interpretive structural modeling

2170

MODELING RELATION²⁾³⁾

The set of **mappings** in the **model** which reflects characteristics of the modelled **entity**.

This is however a matter of **criteria**, which themselves are used by a model builder in base of his/her **frame of references** (as it is when the model is made) and of his/her more or less adequate **perceptions**.

To appreciate the hidden postulates in models construction, the following viewpoints are specially useful:

- von FOERSTER's critique of the **observer's** intervention in the "observed system"²nd order cybernetics)
- KORZYBSKI's scrutinizing of our ways of **abstraction** through his **structural differential**
- KUHN's work on **changes of paradigms** also considered in other studies about our common use of the Cartesian and the Newtonian paradigms (R. ROSEN, for example)
- MATURANA's studies about our ways of perceptual and mental **relationships** with the "world out there" and the quagmire of our supposed **objectivity**.

Finally, it becomes crystal clear that our models can at most be **homomorphic** (in one or another selected way) to the modelled "**object**".

→ **Constructivism; Isomorphism**

2171

MODELING (Systemic)²⁾

G. KLIR explains the status of systems modeling as follows: "What does it mean to **construct** a system that is a **model** of something else? First, it means that a system, when considered on its own, is not a **model**. It becomes a **model** only in a **relationship** to another system, which usually is referred to as an **original**. Furthermore, this relation is not arbitrary, but it must be a **homomorphic relation**".

"A **homomorphic relation** (or **homomorphism**) between two systems is contingent upon a **function** from relevant entities of one system (the original) onto the corresponding entities of the other system (the modeling system), under which the **relation** among the entities is preserved. If the **function**, which is called a **homomorphic function**, is **bijective**, the relation is preserved completely (we say that the two systems are **isomorphic**); otherwise it is preserved only in a simplified form" (1991, p.77).

A perfect **isomorphism** is conceivable only between two (or more) **models**.

KLIR also states: "Systems models are constructed for the purposes of explanation, **prediction**, and sometimes, **retrodiction**" (p.83).

He also distinguishes between:

- 1) the **postulational approach**, in which "... a hypothetical **generative** system or an **epistemological** higher system is postulated ... (as) a result of the scientist's background **knowledge**, experience, insight, intuition and the like. It is a **frame** for a specific type of **deductive reasoning**" (p.83) and
- 2) the **discovery approach** which is **data-driven**: "That is, **models** are derived by **processes** that discover **patterns** in **data** and utilize them for making inductive **inferences**" (p.84).

KLIR adds: "Neither of the two extremes (and idealized) approaches is actually ever used in its pure form in praxis" (p.84).

2172

MODELIZATION: Analytic or systemic^{2) - 3)}

J.L.LE MOIGNE propose the following comparison between the analytic (i.e., applying a **reductionnist method** of successive decomposition) and the systemic (i.e. using a wholesale approach) modes of modelization (1990, p.9): see table next page

One wonders if the systemic way to "control" is not **regulation** or still better **self-regulation**.

Pleasantly, LE MOIGNE argues that cutting a sausage in regular slices can be satisfactory, but that the same method applied to a chicken would not give good results.

D. DURAND describes as follows the successive stages of modelization in systemic terms:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"Analytic

object
Element
Set
 Analyse
 Disjunction (cutting)
Structure
Optimization
Control
Efficiency
 Application
 Evidence
 Causal explanation

Systemic

Process
 Active unit
 System
 Conception
 Conjunction (articulation)
Organization
Fitness
 Intelligence
Effectiveness
 Projection
Relevance
Teleological understanding

"- Identification and **classification** of the **elements** of the system (in order to distinguish) the **elements** in a number of **classes**... taking in account (their) dynamic as well as static properties ... and establishing a certain **hierarchy** among them.

"- Defining the **relations** among the **elements**... This is usually done by establishing a **matrix**... which moreover allows to define the direction of the **relations** from one **element** to another.

"- **Generalization** which is the extension to the most numerous possible **situations**, of a **model** which has been found valid in a number of observed **situations**.

"- **Induction**, a more ambitious **operation**... which aims at the replacement of one or various given **models** by one more abstract and more universal one" (1979, p.58).

2173

MODELIZATION BY COMPUTER (Limits of the)^{3) - 5)}

P. DENNING states such limits in the following way:

"As part of our modeling efforts, we must come to understand the **domains** over which a given **model** is reliable, partly reliable, or unreliable. We must also understand the **situations** in which modelization can be useful as a way of grounding speculations about the future **dynamics** of systems.

"Systems whose **rules** can evolve or change in unpredictable ways are unlikely to have a reliable predictive or speculative **model**.

"We must be careful with the **output** of **models**, being constantly skeptical that these **output** are "**facts**" or are accurate **descriptions** of the world. In our technological age, it is easy to accept the claim that every **phenomena** can ultimately be modeled, given sufficient **knowledge** and computational **resources**. There is reason to doubt this faith.

"If our mood makes us disinclined to accept **complexity**, it is easy to substitute the **model** for reality and to confuse our opinions with "**scientific facts**" supported by the **model**" (1990, p.498).

DENNING admits however that in limited **domains**, it is possible to create **models** of **complex systems** with human participants. But we do not know where the limits are.

This does not preclude using computers to gather and process **information** and make **conditional predictions**, whenever possible, "namely **domains** in which the **rules** are known in advance".

"In all cases, however, we must let the computer support the **decision-maker**, and not let the computer make the **decisions**" (Ibid.).

2174

MODELIZATION (Expediency in)^{2) - 3) - 4)}

J.W. SUTHERLAND describes as follows the unacceptable roots of expediency in modelization (a cause of not a few disasters in **human systems** in general):

"We need a solution but lack an effective instrument to arrive at a solution (a problem which has haunted those who, for example, are trying to develop **game-based models** to attack sociopsychological **behavior**).

"We need a solution, but to apply instruments congruent with the real properties (e.g., the true **complexity**) of the problem would be inefficient or economically infeasible – hence, for example, the tendency of **operations research** and industrial engineering practitioners to assume **linearity** in the face of evidently **nonlinear phenomena**" (1973, p.128).

The pseudo-solutions thus obtained are generally sub-optimal and sometimes, downright erroneous.

2175

MODELIZATION in System Dynamics⁵⁾

According to J.de ROSNAY, to modelize is to "construct a **model**, using the **data** produced by **systems analysis**: To begin with a complete diagram of causal **relations** between the **elements** of different **subsystems** is established (for example: ... influence of natality on **population**, of food rationing on mortality, etc.). Next, the equations which represent the **interactions** and **linkages**... are expressed in a convenient **programming language**." (1975, p.112).

The problem is to construct a "complete" diagram. If the **elements** (or the **subsystems**) are more than a very few, no complete diagram can be practically constructed. If we reduce the number of **components** by **aggregation**, we introduce the problem of establishing sound (in whom's view?) **criteria of aggregation**.

2176

MODELIZATION METHODOLOGY (Systemic)^{1) - 2)}

A. CASELLES MONCHO and J.L. USO DOMENECH propose the following general systemic modelization methodology:

"1. Identification of the **elements** to be considered according to the objectives of the modeler. Degree of detail or **aggregation**.

"2. To give a name, a unit of measure and a **range** of possible values to each **element** determined. So the **elements** are converted in mathematical **variables**.

"3. Identification of the causal dependencies among the **variables** considered.

"4. To assign an equation or table of values to each dependency previously identified.

"5. To **program** the **model** for a computer.

"6. To verify that the **model** fits real **data**.

"7. **Validation** of the **model** for another **set** of **data** obtained from another similar system.

"8. To use the model for testing user policies" (1993, p.457).

The authors aim is the study of **decision-making** problems in enterprise **management**. This type of modelization could however be also used in other fields, as for example, **ecology**.

Their proposals should possibly be somewhat observed. In complex **situations**, it would be better to begin with a **consensual** critical scrutiny of the various participants **objectives**, in order to avoid man-made disasters due to unilateral views of some autocratic **decision makers**.

As to the 2nd point, it is not sure that all **elements** can be converted into mathematical **variables**, specially the motivations of the participants.

Causal dependencies may well be variable in **time**, i.e. at **short, medium or long term**.

Computer modeling (as stated by P. DENNING – see above), has some limits.

Finally, the model should be frequently **re-cycled**: Napoleon once said that the best way to lose a battle is to try to repeat a former victorious one.

2177

MODELS (Dynamic use of)²⁾³⁾

G. MINATI writes: 'The notion of Dynamic Usage of Systems is related to the **situations** in which the system to be studied is so complex that it is not possible, in principle (because of its structural, unpredictable **dynamics**) fully describe it through a single model, nor through a sequence of models. each of which is a refinement of the previous one. In case of so **complex systems** (e.g. biological, social, cognitive systems) this approach makes reference to the ability to select, among the available ones, a number of different models of a given system, in order to simultaneously use them in a systemic way, i.e. the investigator, while being aware of the intrinsic limitations of each one of the models of the same system, makes, not withstanding, use of their results in a "crossed way", taking into account even the mistakes and not only avoiding them. The **strategy** is not to find the "right model, but to use the available ones (available **knowledge**) in an effective way" (2001a, 2002b)

It is possibly more a matter of comparing relative **inconsistencies** than to speak of "mistakes". Models are constructed in some specific way and depend on viewpoints. They can be useful in a complementary way, even if not perfectly "correct"

→ **Homomorphism; Isomorphism**

2178

MODELS (Functions and uses of)^{1) - 2)}

B. WALLISER (1977, p.179-80) distinguishes the four following functions and uses of systems models:

- **cognitive**: The model is used to understand the **interrelations** between the system's **input** and **output variables**;
- **decisional**: The model is used to investigate how the **output variables** should be defined, taking in account the probable **evolution** of the **environmental variables**;
- **normative**: The model is used to define and state the required **relations** between **input** and **output variables** of the system;
- **predictive**: The model is used to **forecast** the **evolution** of the system's **input** and **output variables** in relation to the probable **evolution** of the **environmental variables** and to the defined **command variables**.

These statements seem somewhat restrictive. Models can also be used to describe and investigate other characteristics of the systems, as for instance **limits** of **dynamic stability**, **growth** regimes and their **limits**, internal **constraints** and **adaptations**, etc... provided for the use in the process of model construction of more recent systemic concepts, as **chaos**, **catastrophes**, **fractals**, etc...

Such research could be beneficial for the different uses described by WALLISER.

2179

MODELS (Mathematical) of systems²⁾

A. RAPOPORT discussed the possibilities for creating adequate mathematical models for real systems (1965), in the following terms: "**G.S. theory**... is primarily concerned with the **structures** of systems as defined by the **relations** which the **parts** of a system have to each other, in the way these **relations** determine the dynamic **behavior** of the system (its passage from **state** to **state**), and with the **history** of the system, i.e., its own **development** as a result of the **interactions** with its **environment**.

"A mathematical **general systems theory** provides **descriptions** of these three aspects of systems, namely **structure**, **behavior** and **evolution**, in abstract mathematical language. A typology of systems, accordingly, becomes a mathematical typology. Two systems are identi-

cal if the mathematical **structures** of their respective models are identical (or **isomorphic** to use the mathematical expression)" (1966, p.9).

It had possibly been better to say that two systems may have *more or less* similar mathematical models because their **structures** are **isomorphic**. Of course, RAPOPORT appreciates this point, as he writes, immediately: "The degree of **similarity** between the systems is estimated by the degree in which their mathematical models are related" (Ibid).

→ ("**G.S.T.: Mathematical aspects**").

A unified and synthetic mathematical **G.S. theory** does not seem to exist. What we have are a number of mathematical theories related to some specific **structural** or **functional** aspects of systems.

→ (see also: **G.S.T.: Mathematical aspects, and hereafter**).

Even now, mathematical models for **complex systems** remain a tall order: very much remains to be done.

2180

MODELS (Qualitative)^{2) - 3)}

The progressive **emergence** of G.S.T. goes with the development of mathematical **models** of a more qualitative character than the traditional ones. This corresponds to the need to study the **forms** of structural **organization** as well as the dynamic **transformations** that affect them.

Thus, G.S.T. makes a growing use of:

- classical **topology** (Formerly POINCARÉ's **Analysis situs**)
- **graphs** theory (KOENIG)
- **fractals** theory (MANDELBROT)
- **fuzzy sets** theory (ZADEH)
- **catastrophes** theory (THOM - ZEEMAN)
- **percolation** theory (HAMMERSLEY- GILLES de GENNES)
- deterministic **chaos** (LORENZ, SMALE and many more)
- so-called **games of life** (CONWAY)
- a renewed theory of interconnected **cycles** (EIGEN)

All these theories are in slow **process** of interconnecting and a coherent **set** of typically systemic **models** is now emerging, within however two well different **classes**: static **models** and dynamic ones.

2181

MODELS (Qualitative Analysis of)^{2) - 3)}

J. ARACIL seeks a way out of limited quantitative analysis of **dynamical nonlinear systems** and proposes the following **method**: "... when a **nonlinear** dynamical system is analyzed, before adapting a quantitative **criterion** relative to a **behavior mode** (attractor) is it convenient to study the full class of **behavior modes** that the system can show. That is, before trying to make a **trajectory** generated by μ fit some ob-

servations on δ , it should be analyzed if all the **behavior modes** that can show μ correspond to the ones that show δ . This is the purpose of the **qualitative analysis** of μ .

"To carry out this analysis we use the **phase portrait** of μ , in which the **attractor's structure** of the model μ is shown. Associated with every **attractor** there is a **basin of attraction**. The **basins** are enclosed by **separatrices**. The **state space** is partitioned in the **set** of **basins**. The **phase portrait** supplies an overall view of all the **behavior modes** the system can show." (1986, p.245)

ARACIL bases his qualitative analysis on THOM's **elementary catastrophes**, taking in account **situations** characterized by two alternating **attractors**. It should be interesting to study what happens when the system undergoes a **process** of **dissipative structuration**: this is obviously the case of numerous **concrete systems**, especially complex ecological, economic, business and social systems.

2182

MODELS: Some taxonomies¹⁾

The French author B. WALLISER (1977 - hereafter W) and the Catalan systemist P. VOLTES BOU (1978 - hereafter VB) established different, but more or less complementary taxonomies of models. They have been completed by this compiler (Hereafter F) and coordinated as follows (alphabetic order used):

- **Analogic**: A model obtained by substitution of a **set** of **interrelated** properties by another, **homomorphic** of the former.(VB)

"A typical example are hydraulic **artefacts** used to represent economical or traffic systems" (VB).

- **Closed**: A model that only includes **elements**, **relations** and/or **variables** corresponding to **endogenous states** of a system (W).

- **Digital**: A computer model constructed according to a **binary language** (F).

- **Disaggregative**: A model that can be subdivided into submodels relatively independent from each others (W).

- **Dynamic transferential**: A **linear stationary** and **continuous** model connecting in vectorial fashion **inputs** and **outputs** (W).

These models can lead to problems when one of the conditions limitative to **dynamic stability** is not anymore valid.

- **Formal**: A model established in a logical or **mathematical abstract language** (F).

- **Global**: A model aimed at describing the system as a **set** as complete as possible.(W).

Systems dynamics models aim at globality.

Not for being "global" is the model a complete **description** of the system. It is necessarily obtained by **aggregation**, which implies simplifications. The way this is done reflects the conscious or unconscious **decisions** taken by the **modeler**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Unfortunately, when the results are assessed, they are seldom put into perspective.

As observed with the "**Club of Rome**" models, they become easily controversial.

- **Hierarchical**: A model organized along various **levels of complexity** (F).

When static, they are called "organigrams" (in French and Spanish) and supposed to represent an **organization** in the form of a **pyramid**. When dynamic, they emphasize **regulations** and **controls**. (Flow charts)

- **Iconic**: A model in which the relevant **elements** and properties are represented in a figurative manner at some specified **scale** (VB).

Examples are photographs, drawings, **maps**, **scale** models, BOHR's "planetary" atom, stellar system models, etc... (VB).

- **Interdependent**: A model that may only be fragmented into closely interrelated submodels, representing very strongly **interconnected subsystems** (W).

- **Macroscopic**: A model including only **interrelations** among **variables** at the global **level** of the system (W).

- **Metamodel**: A model of a higher **level of abstraction** which maps the properties of lower systems models into propositions of a higher **level of abstraction** (J.P.van GIGCH, after St. BEER, - 1986, p.3).

van GIGCH states "Of necessity, the metamodel is conceptualised in a **metasystemic** language or metalogic which can decide propositions and reconcile arguments which cannot be decided or reconciled in the **language** or logic of lower systems models" (Ibid).

- **Microscopic**: A model including only **interrelations** among **variables** at the **subsystems levels** of the system (W).

- **Open**: A model that also includes **exogenous variables**, corresponding to **inputs** from the **metasystem** or **environment** and **outputs** into the same (W).

- **Partial**: A model describing merely a fragment of a **subset of phenomena** in the system (W).

- **Physical**: A physical **representation** of the system in form of concrete **processes** (W).

Good examples are reduced models of aircrafts for aerodynamic tests; reduced models of harbours or river basins for the study of currents, silting processes, etc...

- **Recursive**: A model that can be fragmented into *successive* models offering the same intrinsic characteristics (W).

- **Sequential**: A model usable to study **processes** chaining in **time** (W).

In practice, it is quite difficult to create very **reliable** sequential models (i.e. useful for **forecasting purposes**), specially in **complex systems** which may present **chaotic behavior**. Most sequential models study the variations of only one **process**, assuming that all other conditions will remain constant.

- **Short, mean or long term**: Models that emphasize different **time spans** in the systems **behavior** (F).

While it is practically difficult to do, ideally short mean and long term models should be interconnected, even if this may lead to very complicated **periodic** or **chaotic** dynamics.

- **Simultaneous**: A model that represent the **whole structure** of a system at a given moment (W).

Such models could also be called "structural", or "**synchronic**". They are instantaneous and **static**, and thus unfit to trace any **process**. It should never be forgotten that these models practically suppress the **time** dimension and tend sometimes to generate the illusion of total **stability**.

- **Symbolic**: A model that uses letters, numbers and other symbols to represent **variables** and their **interrelations** (VB).

In this sense, "symbolic" is practically equivalent to "formal"

Obviously, a model may include various of the characteristics previously described... Moreover, even WALLISER's and VOLTES BOU's listing remains partial (see former entries).

Other authors proposed different taxonomies of models, some of them more or less complementary, and some others offering finer subdivisions.

A. ROSENBLUETH and N. WIENER (1945) proposed two fundamental classes:

- **Material models**, i.e. simplified material **representations** of some of the characteristics of the original system;

- **Formal models**, i.e. mathematical simplified **representations** of structural or dynamic properties of the system.

D. and G.A. MIRHAM proposed an expanded classification as follows:

"Physical models

Replicas: Biological twins; earthen relief maps Quasi-replicas: Silhouettes; planetarium shows

Analogue: White noise generators, statues

"Symbolic models

Descriptions: Textbook; metaphorical essay

Simulations: Operational, procedural description

Formalizations: Differential equation: Poisson distribution

"Hybrid models

Analogue-similar: Hybrid computer model of river **flow** and **storage**

Replica-descriptive: War gaming exercise

Replica-similar: Operational, computerized, gaming model

Others: Board games, such as Monopoly" (1975, p.43).

So many classes are somewhat baffling, but reflect the considerable **complexity** in the field of model building.

2183

MODELS (Use of Generic and Concrete)²⁾

J. ARACIL explains as follows the use of generic and concrete models for the study of **nonlinear dynamical systems**:

"Once a generic model M has been adopted, we have to choose the model μ M that "best" fits the **concrete system**. The fitting **criterion** between δ and μ is established from **observations** of the **time behavior** of δ . The model $\mu(p)M$ whose **trajectories** best fit the ones observed on δ will be adopted. This fitting **criterion** can be quantitative, formalized through a mathematical expression of the discrepancies between the data observed on δ and the ones generated by μ . It is very common to use the quadratic value of this discrepancy. This **criterion** has a strongly local character as far as it refers to a **trajectory** (the measured one) which is adopted as representative of the **behavior mode**. However, it is well known that a *nonlinear dynamical system can have many attractors and therefore, can show different behaviors associated to them*. In that case, if one adopts a single **trajectory** as representative of the **behavior** of the system, then one is self-restricted to one **attractor**, forgetting the other ones, and the analysis of the system is unfailingly defective" (1986, p.245).

This is a characteristic problem presented by FORRESTER's **systems dynamics**: what happens when some systemic **process** escapes from its supposedly normal **range of trajectories**? and what should be done in such case?

ARACIL's qualitative analysis of models tries to solve this problem.

2184

MODULARITY (Weak)^{1) - 2)}

The existence in **subsystems** of moderately **constrained networks**, which carry out some more specific **activity**.

A **subsystem** in a **complex system** is generally made of **modules**, whose **interconnections** allow for the global functionality of the **subsystem**.

An example is sight, an **array** of interconnected **perceptions networks** referred to **form**, **size**, distance, color and movement.

Modularity must not be overly **constrained**, in order to allow for **adaptiveness** within the constitutive **networks**.

Weak modularity could probably become a useful concept for the study of **social systems** as, for instance, **organizations** or even for the future construction of **groups of artefacts** endowed with **distributed artificial intelligence**.

→ **Hora and Tempus parable**

2185

MODULATION ²⁾ - ⁵⁾

A variation in the **amplitude**, **frequency** or intensity of a **wave** or **oscillation**.

Modulation according to a law or **code** allows for the **transmission** of **messages**.

2186

MODULE ¹⁾ - ²⁾

Any standard structural **element** that may replace another **element** of the same type or **class** in a system or a **subsystem**, or be added to it.

Modules are generally of finite duration, as for example molecules, **cells**, snow flakes, or living beings.

According to L. CARLSON-SABELLI and H. SABELLI "The universe is formed by **classes** of similar entities (modules) at each **level of organization** (electrons, sodium atoms, starfish, system theorists). This is the principle of uniform **structure** of nature (MILL) also called the principle of mass production (J. THOMSON). For each **class** of modules there necessarily is a complementary **class**: cation and anion; sun and planet; woman and man; teacher and student, etc.)...

"Modules can be exchanged for each other as **parts** of systems. An entity may readily change the system to which it belongs, but not its **class**. One module may replace another in a system without affecting its overall **function**. Modules, even when equivalent to each other within the **context** of a given **interaction**, may not be equivalent in relation to other **interactions**, and may be completely unique (e.g. snow flakes, human beings, books). Systems are formed by modules of many types, and often contain many individuals of each **class**. **Complementary** modules interact harmonically, conflictually and co-creatively. Social classes are obvious examples" (1993, p.682).

→ **Hora and Tempus parable**

2187

MONAD ^{2/3)}

An entity made of only one **element**.

This abstract term was created by LEIBNIZ (1646-1716) to characterize an indivisible unit of some substance conjectured to be the fundamental **element** of physical **reality**.

LEIBNIZ admitted however that monads could not exist without **relations** which each other.

The leibnizian concept seems to announce the notions of "**whole**" and "**system**".

→ **for comparison: Entitation; System (Isolated)**

2188

MONEY A systemic definition ^{4/5)}

"An agreement within a **community** to use something as a medium of exchange"

(Bernard LIETAER: pers. comm. Oct. 28th, 1996))

LIETAER states: "Money as an agreement, lives in the same space as other social **constructs**, such as political parties, nationality, gender or marriage. These constructs are real, even if they only exist in people's heads. The money agreement can be attained formally or informally, freely or coerced, consciously or unconsciously...

"The agreement is always valid only within a given **community**... Such a **community** can be the entire global economy (as is the case of the U.S. Dollar by treaty as long as it is accepted as reserve currency), or a geographically disparate **group** (such as Internet participants).

"Finally, the key **function** that transforms the chosen object into a currency is its role as medium of exchange" (Ibid)

In archaic **cultures**, a wide variety of objects have been used as currency: cowries shells, lumps of salt, beads, pigs, cows and generally any type of objects that can be given a so-called **value** and handled over in transactions, which are a specific form of **communication**.

2189

MONITORING ¹⁾

Watch keeping and registering of specific **data** about the **activity of a system** and/or the **changes** in its **environment**.

On this last aspect W.D. GROSSMANN and K.E.F. WATT comment: "Monitoring of the **environment** provides the basis for two tasks: **homeostasis** and **adaptation**, and **error** correction. Monitoring is necessary because no perfect anticipation is available, otherwise it would not be needed. Capabilities for anticipation will be vastly improved, but will remain limited because of partial **unpredictability** of systems. In fact, it can be expected that anticipation will be wrong very often, perhaps most of the time in **complex systems**" (1992, p.20).

The authors recommend: "Development of a **set** of guidelines which specify the maximum tolerable **deviation** of indices of potential threats from their "standard values" or "standard long-run **trajectories**" (p.37).

This would be doubtless very useful. It should however be supplemented by a kind of "qualitative" monitoring, corresponding to basic **mutations** related to the **emergence** of new **structures** and **functions** through **dissipation** in a world in which natural **homeostasis** of

ecosystems and human ones cannot anymore be taken for granted.

Monitoring can be improved in **time** as the most significant possible **changes** affecting **short, medium and long term trends** become more manifest, and as the possible impacts of some hitherto ill known factors become more visible, i.e. when the **observer** learns *what to look for*.

The results should be translated in easy to understand **form** for the use of **decision makers**, insisting however on the always somewhat imperfect character of the conclusions that can be drawn.

Monitoring in systemic terms should never be limited to some selected **processes**, isolated from **context**: it is the system as a **whole**, whose **fitness**, **stability**, or even global **evolution** in relation to its changing **environment**, should be watched.

2190

MONOCULTURE ¹⁾ - ⁴⁾ - ⁵⁾

"The cultivation of a single crop to the exclusion of other crops on the land, i.e. in contrast to having a **variety** of different crops on the same land" (UNESCO - UNEP, 1983, p.18).

"Monocultures are often very susceptible to pests and diseases because of their concentration" (Ibid).

Monoculture is a typical violation of ASHBY's **Principle of Requisite Variety**. It is also a typical case of **suboptimization** in the name of **maximization**.

This problem is of much wider scope than agricultural. One could speak of mono-anticulture in the fight against pests and pathogens, where we produce evermore resistant strains by a kind of "inverse **selection**".

One may even wonder if the present human overwhelming **population explosion** is not the result of a kind of gigantic and unconscious "monoculture" experiment. It is at least characterized by a massive destruction of biological **variety** and seems to lead to an increased susceptibility to global "pests and diseases because of... concentration"

The UNESCO-UNEP glossary proposes "multiple use" as a corrective policy, i.e. the "coordinated **management** and **planning** for the most judicious and harmonious use of the land on a **long term** basis under the concept of combining two or more uses and/or **purposes** with attention to **sustainability** and nonimpairment to the natural **resources**" (Ibid).

A general **understanding** of the systemic and cybernetic concepts and **models** seems a prerequisite for the adoption by economists, politicians and social leaders of corresponding politics worldwide.

2191

MONOTONY PRINCIPLE (of Arnaud DANCHIN)²⁾

Only a limited number of internal different **translations** are produced by a pluralism of receivers. (J.C. TABARY, 1989, p.279)

2192

MORALITY⁴⁾

"In a **social system**, the totality of the conditions for deciding the bestowal of esteem or disdain within the system" (K. BAUSCH, Glossary, Pers. comm., 2002)

This definition has been inspired by N. LUHMANN's views. It clearly describes morality as a socio-cultural values defining code, most generally based on non-rational mythical beliefs or religious faith. Morality is a symbolic generalization that reduces the full reflexive **complexity** of double contingent ego/alter **relations**... and by this generalization opens up 1) room for the freeplay of conditionings, and 2) the possibility of reconstructing complexity through the binary schematism esteem/disdain".

Morality is thus essentially a social **set of constraints**. However, it is clear that the obedience to these constraints is basically a mere insurance against getting in trouble.

Ethics on the contrary engages personal **responsability** for one's own **behavior**, and may in some cases lead to a rebellion against social constraints imposed by moral in the **meaning** of LUHMANN.

Consequently, morality is not universal in an absolute sense. Some specific **behavior** can easily be praised, or even made obligatory in one **culture** and abhorred and even prohibited in another. Examples abound.

Any morality, specific to a culture, is transmitted by conditioning, generally since the most tender age. It thus becomes ingrained and escapes any critical reappraisal.

This leads to a set of standardized behaviors, not anymore discusses by anybody (in German "**Gleichschaltung**")

In this way many possible **conflicts** are avoided eliminated or at least made infrequent and much more easily evaluated and reduced within a **community** that obey stable and clear **rules** and prescriptions.

Morality is, or better, moralities are thus basically social devices and as such quite different and more limited in scope than **ethics**, which is more concerned with the deepest human nature, man's relation with his living the deepest human nature, man's relation with his living and non-living **environment** and the most existential question marks. (See H.von FOERSTER and M. BRÖCKER, 2002)

→ **Ethics and Morality**

2193

MORALITY (Ethics and)

→ **Ethics and Morality**

2194

MORALITY (Management and systems)

→ **Management and Systems Morality**

2195

MORPHIC FIELD²⁾

A field of **information** which would exert a formative power over **processes** (adapted from F. DAVID PEAT, 1988, p.62).

This still quite controversial concept has been introduced by R. SHELDRAKE. (1982)

F. DAVID PEAT writes: "It appears that WADINGTON was moving toward a notion of **development** in which living **matter** in some way responds to a **field of information** which exerts a formative power over the **processes** of the **cell**..."

"SHELDRAKE has proposed that such **fields of information** do exist and influence the **structures** not only of living **organisms** but of inanimate **matter** as well. According to SHELDRAKE, all **matter** has an associated **field of memory** which plays an active role in guiding the formation of **structures** and various **processes**. Clearly if SHELDRAKE's idea is taken seriously, then it would extend the nature of **matter** by introducing a new **level**, that of active **information**" (1988, p.162).

And: "These morphic fields are a type of **memory** that acts like a formative **pattern** with regard to material **structures** and **patterns of behavior**" (Ibid, p.166).

SHELDRAKE formulated his "**Hypothesis of formative causation**", of Aristotelian flavor, and derived from the different **morphogenetic field** concept, as a basis for his morphic fields. J. CASTI resumes it as follows:

"1. **Morphogenetic fields** are physically real;

"2. These **fields** shape and organize developing plants and animals, as well as stabilize the **forms** of adult **organisms**;

"3. Each kind of cell, tissue, organ, and **organism** has its own kind of **field**;

"4. The **morphogenetic field** results from the actual **forms** of previous **organisms**" (1990, p.175).

As observed by F.D. PEAT: "Little in the way of original research has been done, so that the overall weight of evidence is not particularly compelling" (p.164).

Features like **anagenesis**, Pasteurian **asymmetry**, **aura**, **licker noise** in **criticality**, **holograms**, homeoboxes (in embryology), **non-locality**, **order from order**, **pattern recognition**, MINKOWSKI's **space-time** diamond, or **stig-**

mergy could be considered as related to the morphic fields hypothesis, since all imply some kind of informative **action** at a distance in **space** and/or **time**.

However, the different problem of *instant correlation* in **space-time** remains unresolved.

2196

MORPHIC RESONANCE²⁾

An hypothetical mechanism of a nonenergetic **transfer of information** at a distance from one entity to another.

This is another hypothesis proposed by SHELDRAKE to sustain his "**morphic fields**" concept.

J. CASTI synthesizes it as follows: "Morphic resonance... takes place on the basis of **similarity**, and involves a nonenergetic **transfer of information**. Thus, it is a kind of action at a distance in **time** and **space**." (1990, p.175).

As observed by CASTI, such views are anathema to most mainstream biologists, who question the "nonenergetic" **transfer** as well as the mysterious character of this kind of **action** at a distance. Similar problems arise with BOHM's **implicate order**.

If SHELDRAKE's views should be admitted, they would quite probably imply a fundamental rehearsal of our **representations** of **time** and **space**.

2197

MORPHISM²⁾

A behavior and, or **structure** preserving **mapping**.

F. SUPPE, who resumes B. P. ZEIGLER's "Theory of **Modeling** and **Simulation**" explains: "In the case of *modeling*, the morphism is a **mapping** from *base models* to *lumped models*. The former are (usually unknown) isolated (i.e. **input-free**) **automata** systems that structurally characterize a portion of reality (a closed body of potentially acquirable **data**); the latter, the *lumped models*, are (simpler) **automaton** systems. Similarly, **simulation** is construed as an appropriate morphism holding between the **computer program** specification and the **lumped model**. One simulates reality by correctly simulating a valid **model** of reality or its **base model**".

"Morphisms are **mappings** between systems which preserve **behavior** and/or "**structure**", and, depending upon how much is preserved, a **variety** of different types of morphisms are possible" (1978, p.128).

It is thus very important to understand that only some specific **parts** of **behavior** or **structure** are mapped, which imply again, this time in **computer simulation** that "the map is not the territory".

2198

MORPHOCATALYSIS^{1) - 2)}

"A **morphogenetic change** in a system's **structure** conditioned by that system's contact or co-presence with another system, **variable** or **event**" (K. KRIPPENDORFF, 1986, p.51).

KRIPPENDORFF comments on his definition: "... neither causes the **change** in the sense of forcing an **adaptation** nor provides instructions directing that **change** in the sense of an **organizational input**" (1986, p.51).

Thus, morphocatalysis seems akin to **coevolution** and could be a natural result of **asymmetries**, as proposed by H. KUHN (1976).

2199

MORPHODYNAMICS^{1) - 2)}

The discipline that "deals with **complex systems** formed of many physical particles of various species"

R. FIVAZ, who gives this definition, states: "Such systems generally are endowed of **stationary states** in which they subsist in the mean **term**. During this **time**, they deliver definite **functions** at a constant **rate** that maintain them in permanent **interaction** with the **environment**... The generic assumptions of morphodynamics include that **order** is acquired according to the leading modalities found in physics, namely through *transitions on cusps*, and that the *structures* so acquired perform the *functions* belonging to the **stationary state**" (1993, p.35).

R. FIVAZ writes: "Morphodynamics specifically concerns **complex systems** where **structures** and **functions** generate each other, i. e. each **structure** supports all or part of a **function** and each **function** participates in the maintenance of one or several **structures**" and "Morphodynamics considers **complex systems** as assemblies of distinct physical **subsystems** embedded in the natural **environment**. A morphodynamical system satisfies three constructive hypotheses:

1. **Structural hypothesis**: Each **subsystem** is ordered in **structures** specified by **order parameters** q_i coupled to external **parameters**; in technical terms, **subsystems** are driven **far from equilibrium** and switch **structures** according to **bifurcation** theory.

2. **Functional hypothesis**: Each **subsystem** carries out a **function** p_i at a rate depending on its **order parameter**; in technical terms, **subsystems** are open and exchange **energy** and **matter** with the outside.

3. **Ergodic hypothesis**: The natural **environment** includes a large set of external **parameters** l_i that fluctuate randomly in **time** and/or in **space**; in technical terms, all **configurations** of this **set** of parameters are accessed in due **time** with equal **probability**" (1996, p. 128)

It should be observed that **fluctuations** need necessarily the **time dimension**. Also, while it appears basically correct, the **ergodic** hypothesis thus formulated is ambiguous: the "due **time**" is quite variable according to the different **configurations**..

As **structures** may interact in a **nonlinear** way, "in the **long term**, these compounded **behaviors** justify the repeated applications of the **ergodic** hypothesis" (Ibid).

FIVAZ proposes a formalism to sustain his ideas.

2200

MORPHOGEN²⁾

"A mathematical **model** involving the **process** of reaction and diffusion of various unspecified chemical compounds" (J. CASTI, 1994, p.71 – after A. TURING).

Morphogens are still purely hypothetical **models**, none having "ever been indisputably identified in the lab" (p.78). It seems doubtful that any will ever be, because if they are more than **computer models**, they must be reciprocal **self-organizing processes**, different in every case, while similar in principle. In biological examples, according to CASTI: "... concentrations... are assumed to be determined by a dynamical system describing how the morphogens interact and change their **levels** and **types** over the course of time" (p.71).

2201

MORPHOGENESIS^{1) - 2)}

The progressive buildup of the structural **organization** of a system and of the **interrelations** among its **parts**.

Already in 1952, A. TURING demonstrated, at least theoretically that some chemicals **homogeneously** distributed at the start, may, by reaction and diffusion, lead to different concentrations, which can then form spatial **structures**. Allegedly, and against what CASTI states, these "TURING structures" have been obtained in France in 1990. (S. DOUADY and Y. COUDER, 1993, p.32).

Morphogenesis, once started, is unavoidably a systemic **process**. It is also a social one because it organizes the differentiation of **parts**, **elements**, **individuals** or **subsystems** that will have to interact during the whole existence of the system.

Morphogenesis thus defined takes place in a system already endowed with **organizational closure**. It consists in the progressive **development** of a **set** of **catalytic hypercycles** – i.e. **periodic phenomena** – which expresses its potential to reach a final **level** of **dynamic stability**.

During morphogenesis, any **growth process** remains closely channeled within maxima and minima **limits** (WADDINGTON's **chreods**). **Structural organization** may be modified,

even deeply, through geometrical and topological **transformations**, but never in such a way as to alter the initial and basic **identity** of the system.

According to H.T. ODUM, morphogenesis is a result of progressive **selection** of successive **loops** which become stabilized if and when some **outputs** are repeatedly fed back into those functional **circuits** that are able to produce them anew. (see "reward loop"). As the initial cause of such **circuits** he sees "the initial proliferation of many possible **connections** more or less at **random** (which) constitutes the **choice** generation" (1977, p.154).

The most significant part of this statement may well be "more or less": Absolute **randomness** is obviously impossible, as any system has some specific antecedents. (See the critique of von FOERSTER's "order from noise" experiment).

However ODUM's view introduces us into the social aspects of **self-organizing systems**.

For A. WILDEN, morphogenesis is the characteristic of a complex and evolving system which adapt itself by transforming its **structures**.

According to WILDEN the term should be reserved for the **behavior** of "complex systems, such as societies... No individual **organism** is able to adapt and develop itself outside of narrow **limits** – in view that any **growth process** is a **positive feedback** which must be inhibited – while the morphogenetic system can adapt itself by transforming its **structures**" (1972, p.58).

Again here, "narrow" remains a matter of definition.

It could possibly be said that any system undergoes a period of social **organization** (biological, neural or groupal of some kind), corresponding with its **growth**, before it reaches its mature **state**. Some basic original **template** creates and transforms the **structures** of the system in a repetitive **process** of at least partial deconstruction and reconstruction, i.e. reorganization of **interrelations** among **elements**. It would seem that this is confirmed by the research in developmental genetics by the 1995 Nobel Physiology laureates: E. LEWIS, C. NÜS-SLEIN-VOLHARD and E. WIESCHAUS.

As this **phenomenon** is **energy**-dependent, it would be necessary to harmonize this **concept** with PRIGOGINE's one of **dissipative structuration** in **systems faraway from equilibrium**. The difference seems to be between some development limitations by pre-programming (for ex. genetic, technical, economic, or socio-cultural) and a nearly wholesale new programming, after an overwhelming shattering of previous **order** through **giant fluctuations** induced by massive **energy inputs**.

A similar potential contradiction is latent in MARUYAMA's concepts of morphogenesis in systems which present "**deviation- amplifying**" **processes** (which could be – or not? equated to PRIGOGINE's giant **fluctuations**) and **morphostasis** in systems with mutual **negative feedbacks**.

Morphogenesis is system-constructive while **morphostasis** is system-stabilizing. But, if morphogenesis is not somehow **constrained** within **channels (chreods)**, and limited in time, it becomes system-destructive, even if it may in some cases lead to **the emergence** of a more complex system.

→ **Autogenetic systems precursor; Zero system**

2202

MORPHOGENESIS as EMERGENCE²⁾

F. ROBB considers morphogenesis as the basic **process** leading to **emergence**: "Morphogenesis, the **emergence** of a system of higher logical **order** or the construction of the existant **order**, involves dissipating much more free **energy** and would be a much more powerful **attractor** than **morphostasis**, providing, as it does, many **positive amplifying feedback loops**. Once the conditions are ripe for morphogenesis there must follow a cascade of **events** leading to a more efficient **energy dissipating system**" (1990, p.141).

Dissipation, in the BÉNARD's sense, produces **structuration**, i.e. the appearance of new "**forms**". In this way the use of the word "morphogenesis" (shaping of **form**) seems justifiable.

2203

MORPHOGENESIS (ENVIRONMENT and ENVIRONMENT in)^{1) - 2)}

Provided the former **emergence** of an **archetype**, the construction of new **elements** or individuals of the same type seems to obey the two basic following **rules**:

1. There exists an internal **mode of organization** of the **endogenous parts**, based on an *implicit* blueprint of their **interrelations**, which leads to the production of characteristic **structures** and **functions**.

This seemingly tautological concept reflects probably an *aptitude* for **co-operation** at the superior **level of organization**, already present in the **archetype**.

2. Environmental **signals** serve as **trigger** factors or as **constraints**.

A good example is the construction of the neuron's axon and dendrites, as researched by M. KIRSCHNER and T. HUTCHINSON (1986, p.329-342).

2204

MORPHOGENETIC FIELD²⁾

"An assembly of functionally coupled **cells** whose **development** is under the **control** of a common regulatory **process**" (G. NICOLIS & I. PRIGOGINE, 1978, p.24).

Such a regulatory **process** in a growing living **organism** secures the coherent ordering of its **parts**.

Morphogenetic fields secure that the dog will have four legs, two ears, two eyes, etc. and that all these **parts** will be orderly located in the global **organism**.

Their nature and **operation** remain still ill understood, but is actively researched, notably in France in Germany, in the U.K. and in the United States.

In France, B. WEISSBERG distinguishes static **fields** from dynamical ones, all however characterized by **rhythms** and **rhythmic synchronies**. For him, spatial **organization** is borne out of the "separation of territories corresponding to opposed **phases**" (an idea reminiscent of SABELLI's complementarity of **opposites**), while "**periodical signals** lead to **periodical responses**". Moreover, dynamic **fields**, (or **toroids**, or **vortexes**, or whorls) result of the **interactions** between two or more **periodic fields**. Finally, "a disappeared **periodic field** may leave marks of its geometric **structure** in an appropriate **medium**". This seems to correspond to PRAT's "**aura**" (1968, p.3-19).

In England, B. GOODWIN states: "The spatial **organization** of the **whole** derives from principles relating to global **field behavior**, together with **constraints** coming from the properties of the entities which are generated as **parts**" (As quoted by J. CASTI, 1990, p.171).

Morphogenetic fields seem to be related to "the existence of inhomogeneous **distributions** of chemicals, the so-called **morphogens** throughout the morphogenetic **field**" (I. PRIGOGINE and P.M. ALLEN, 1982, p.19).

According to G. NICOLIS and I. PRIGOGINE: "This suggest that at least early morphogenesis is a **symmetry-breaking process** associated with the formation of spatial compartments in a hitherto **homogeneous tissue**" (1978, p.25).

Again, this seems in accordance with the 1995 Nobel Physiology laureates research in developmental genetics. (New Scientist, nr 1999, p. 6, 1995).

Morphogenetic fields should not be confused with SHELDRAKE's **morphic fields**, even if this author rely on morphogenetic fields to establish his "Hypothesis of formative causation".

2205

MORPHOLOGICAL RESEARCH⁵⁾

"A **forecasting** technique used in both **Operation Research** and **Market Research** which involves **forecasting** and **goal-setting**" (I.G. BLOOR, 1987, p.31).

This is a very systemic technique. BLOOR expresses: "The core part of the technique requires "total thinking" exploratory **processes** (i.e. gathering and analysing **data** in **context** and not isolation such as assessing the **effects** of a new technology on an industrially depressed area). The results are **predictions** relating to a "whole future" for an entire **organization**. **Morphology** is the science of the study of the **structure** or **organisms** in a complete **state**".

The FUSCHL Group proposed in 1984-85 the use of multi-dimensional **matrixes** to develop morphological analysis.

"Each multidimensional intersect would contain **information** on how the various **categories** of the various **taxonomies** of **parameters** (represented by all axes) interact with each other" (L. TRONCALE, 1985, p.73).

While this kind of **matrixes** – very complex in themselves – would not yield results of higher quality than the **inputs** themselves, they should at least offer an all-embracing **combinatorics** of **linkages**, some of them probably unexpected and interesting.

2206

MORPHOLOGY¹⁾

The **structure** and **forms** of a system.

The science of **forms** and their **transformations**.

The term was originally introduced by GOETHE (1749-1832), with the **meaning** of "Study of **forms** and their **changes**" (A. GOPOLD, 2000, p. 101)

The subject has been extensively researched in botany through phyllotaxis (by the brothers BRAVAIS, by HOFMEISTER during the 19th Century and more recently other researchers (S. DOUADY and Y. COUDER, 1993), and more generally by d'Arcy W. THOMPSON (1916/1952) and, at a higher **level of abstraction**, by CH. LAVILLE (1950).

Morphology is, of course, the progressive and final result of a **morphogenetic process** or, in D. BOHM's terms, of a "**generative order**", a possibly more general notion, because BOHM's global "implicate order" **embeds** every possible type of **morphogenesis**. In D. BOHM and F. DAVID PEAT's words: "... the inclusiveness of **orders**, one within the other, is no longer a mere abstract **subsumption** in the sense that a more general **category** contains its particulars. Rather the general is now seen to be present **concretely**, as the **activity** of the **generative principle** within the **generative order**" (1987, p.164) (emphasis ours).

Morphological properties – as a typical systemic subject – show quite interesting **isomorphies** between numerous systems and **organisms**. These can be framed within very general

underlying properties of **energy fields** and, at a still more abstract **level** by mathematical regularities through **FIBONACCI series** and the related **Golden Section**.

In a more specialized **meaning**, in linguistics and applicable to artificial intelligence, morphology is the study of word formation, derivations and flections.

2207

MORPHOLOGY (Dynamic)²⁾

Capacity of the system to maintain its **structures** and **functions** (or **organization**) during a long lapse of **time**.

This expression has been proposed by L.von BERTALANFFY (1969, p.81). It refers to the set of the **steady processes** which provide the **maintenance** of the system.

The subject has been enormously enriched first by classical **topology** and, more recently, by the concepts and **models** of **catastrophes**, **fractals**, **dissipative structures**, **bifurcations** and **chaotic behavior**.

2208

MORPHOMETRY (Geometric)²⁾

A discipline which quantifies the geometric **similarities** and dissimilarities among the **forms** of living beings.

The original idea belongs to W. d'ARCY THOMPSON (1916).

It was based on the study of **topologic** deformations, through the comparison of a number of **homologous** points taken on two **objects** (D. BRUNO & B. LAURIN, 1997).

It is now used in paleontology as a tool to measure the morphologic distance between species which are supposed to belong to a specific evolutive line.

It could however probably be applied to any evolutive series of objects, even man-made **artifacts**.

2209

MORPHOSPACE²⁾⁵⁾

The **domain** of space wherein a specific regional **regulation** imposes defined **processes** and **forms**.

This is a biological concept, related to the orderly **self-construction** of living beings. Its first inspiration can be however found in the 19th Century CHLADNI's magnetic figures and in W. d'ARCY THOMPSON's work on "**Growth and Form**" (1916).

2210

MORPHOSTASIS^{1) - 2) - 4)}

"The **processes** in **complex system-environment** exchanges that tend to preserve or maintain a system's given **form**, **organization** or **state**" (E. LASZLO, 1974, p.35).

"Character of a system which in spite of **perturbations** it must endure, goes back to one of the **states** included in its **repertory** and maintains its **organization** within clearly defined limits" (p.35).

To maintain itself in morphostasis, the system needs to be able to correct any **deviation** from the **set** of its admitted **repertory** of **states**. This is obtained by a predominance of **negative feedbacks** when the system is coming too close to some **instability threshold**.

Morphostasis is also a necessary consequence of **organizational closure** and **auto-poiesis**.

LASZLO gives the following example; "**Negative feedback** (morphostatic) **processes** dominate when **innovation** in a society is at a low ebb and the society is primarily devoted to coping with its **environmental** contingencies through the existing **norms** and **codes** of organized **behavior**" (Ibid, p.36-37).

2211

MOSAIC²⁾

A patchy spatial **distribution** of **elements** or conditions of different **classes** in an **environment**.

This type of **situation** happens in mostly **heterogeneous** and not strongly **hierarchic** and **integrated environments**, as for example **ecosystems**, **sociosystems** and global economic systems.

It is conducive to **variety** and **resilience**.

Mosaics correspond to:

- **heterogeneity** of **sets** of **elements** endowed with different characteristics.
- fluctuating and shifting occupancy of specific **territories**.

However a more general **homogeneous** common **substrate** or **medium** is a requisite.

Ecosystems, offering a wide **variety** of local conditions, are normally mosaics. It can be also the case of **socio-technical** and **cultural systems**.

→ "**Patchiness**"

2212

MOSCOW SYNERGETIC SCHOOL (The)¹⁾

This scientific school, a part of the Keldysh Institute of Applied Mathematics (Prof. S.P. KUDYUMOV) and the Institute of Mathematical Modeling (Prof. A.A. SAMARSKII) of the Russian Academy of Sciences, is the leading school in the field of synergetics (the theory of **self-organization** and **evolution** of **complex systems**) in Russia.

Its activity is centered on the exploration of very fast developing **processes** and of their self-strengthening in open **nonlinear** media, so-called blow-up **regimes** as well as various types of blow-up in the bibliographic section.

"The research is focused on the analytical methods of solution based on complicated **nonlinear** equations ... as well as on computer experiments with evolutionary **processes** in open **nonlinear systems**. **Synergetics** is developed ... as a theory of non-stationary localized **dissipative structures** which are a new type of ordered **structures** in systems with **nonlinear positive feedbacks**. (It is) viewed as a theory of fast evolutionary **processes**, the formation of localized **structures**, their **transformations**, **co-evolution**, **synthesis** and **decay**".

The main lines of research are defined as follows:

"1. The investigation of **mechanisms** of the **processes localization** in form of **structures** of an open **nonlinear medium**...

"2. The idea of **discrete spectra** of **dissipative structures-attractors** in open **nonlinear media** has been propounded...

"3. The exploration of very fast developing **processes** and of their self-strengthening in open **nonlinear media**, (so-called blow up **regimes**...)

"4. ... the principles of **integration**, construction of complex **structures** from **structures** which develop with different speeds and are at different stages of **evolution**.

"5. The revelation of the principles of **non-linear** management (the crucial role of weak, but **topologically** rightly organized influences upon **complex systems** for effective management" (Quotes from a pers. comm. by Prof. Elena KNYAZEVA, (knyazeva@iph.ras.ru)

2213

MOTIVATOR^{1) - 4)}

"The generator of system needs." (I.V. BLAUBERG et. al., 1977, p.163).

This term has been proposed by QUASTLER in his paper "General Principles of System Analysis" (see BLAUBERG et al., p.163).

It appears somewhat anthropomorphic, even if the genetic code in a **living system** could be an example as well as the basic **set** of **values** in a human **group** or the by-laws that reflect these **values** and constraint **activities**.

2214

MOTOR^{1) - 2)}

"The **subsystem** which moves the system or **parts** of it in relation to part or all of its **environment**, or moves **components** of its **environment** in relation to each other" (J.G. MILLER, 1978 p.3).

This is the ninth of J. MILLER's **20 critical subsystems** of a **living system**. It is a **subsystem** that processes **matter** and **energy**. In living beings, arms or limbs are motors. In **organizations**, examples are cranes, tractors, trolleys, moving assembly lines, etc... In the

supranational system railroads, airplanes, seafaring vessels, trucks, etc... seem to perform motor roles.

2215

MOVING AVERAGES²⁾

"A flexible mathematical **method** of smoothing statistical **data**" (E. Dewey & E. Dakin, 1952, p. 248)

This smoothing process is of great interest for a better understanding of the fundamental evolving **trends** in **growth** curves.

The authors give the example of a 2 year moving average applied to a collection of annual data. For instance, it can be done in a progressive way by adding series of 4 successive yearly totals and dividing the result by 4. Thereafter, pairing the results and dividing them by 2, the most extreme **fluctuations** of the base data are smoothed.

The authors state "...a moving average has no effect on the **period** or length of the series being averaged. But it does have an effect upon the **amplitude** of the **waves**" (p. 251)

Moving averages eliminate the apparent general **randomness** of data and show the basic **rhythms** of the **process** under study.

2216

MULTI-AGENTS SYSTEM^{1) - 2)}

A **network** composed of numerous interconnected **elements** or individuals.

This very general **model** is derived from the concept of distributed **artificial intelligence**.

As stated by J. ERCEAU and J. FERBER, it offers a frame for the study of: "... the **behavior** of a **set** of more or less expert entities, more or less organized along social type laws. These entities or *agents* benefit from a certain degree of **autonomy**, and are immersed in some **environment** in which and with which they interact. They are structured around three **functions**: to perceive, decide and/or act. They can be physical **entities** (sensors, processors, vehicles, ...) or abstract ones (tasks to be performed, movements,...). Through reciprocal information transmission, they become able to act on their **environment** and upon themselves, i.e. to modify their own **behavior**. To this end, they are endowed with a *partial representation* of this **environment** and with **perception** and **communication** means".

"As their **behavior** is based on an a priori or on *acquired knowledge*, agents include two main features. The first one is a *social tendency*, oriented towards the collectivity: this is the conversational and relational **domain**, and the corresponding **mechanisms** and associated **knowledge** bases are related to the **group's activity**. The other is the *individual*

tendency. in this case, the register is about **knowledge** and **behavior**, with **mechanisms** and **knowledge** bases including **rules** for the internal workings of the agent" (1991, p.752).

What the authors describe are **networks** of artificial agents (robots of limited individual abilities). But the **model** also strikingly suggests **analogies** with human and, probably, insects societies.

Networks of this type are most generally decentralized, since their **organization**, while in need and in search of **coherence**, is a result of more or less free, local and specific **interrelations**. As an example, R. BROOKS proposes micro-robots "societies" that would be used for planetary exploration, in which case the sideral distances make **efficient communications** with any earth based users quite difficult, due to **time lags** (1989).

2217

MULTI-AGENTS SYSTEM STRUCTURE²⁾

J. FERBER describes (1999) the multi-agents system, which includes the following aspects:

"1- an **environment**, that is, a **space** which generally has a volume

2-a set of **objects** that is situated, that is to say that it is possible at a given moment to associate any object with a **position** in the **environment**. Some objects are passive, that is they can be perceived, created, destroyed and modified by active objects (note of ed.: active objects are supposedly "agents")

3-an assembly of agents, which are specific objects, representing the active objects of the system

4-an assembly of **relations**, which link objects (and thus agents) to each other

5-an assembly of **operations**, making it possible for the agents to perceive, produce, consume, transform, and manipulate objects.

6-operators with the task of representing the application of these operations and the reaction of the world to this attempt at modification, which we shall call the laws of the **universe**" (1999)

To speak here of "the world" and the "laws of the universe" seems a bit of an overstatement. Possibly the author wanted to say "environment"

In any case, this proposed **model** seems applicable to a number of quite different types of **self-organizing systems** (natural or artificial)

→ **Artificial life; Parallel distributed processing; Relations; Stigmergy; Swarm; Zero system**

2218

MULTIDIRECTIONALISM¹⁾²⁾

A **communication process** which combines **top-down** communication with **bottom-up** (or sideways) feedbacks.

Basically, multidirectionalism needs and uses **networking** and gives voice to any participant who wants to take an active role. Such a stand moreover enhances the work of all participants and empowers the **group** as a **whole**.

It does not however necessarily implies that the group's **activity** is positive for the society as a whole.

→ **Multiperspectivism; Unidirectionalism**

2219

MULTIDISCIPLINARITY^{1) - 3) - 4)}

"A collective study by many specialized experts of a complex project or problem" (Ch. FRANÇOIS, 1986, p.114).

Ch. FRANÇOIS carefully distinguishes multidisciplinary from **interdisciplinarity**, or **transdisciplinarity**.

He writes: "Multidisciplinarity reflects the ever growing need for collaboration among many disciplinary specialists for the management of **complex systems**. Unfortunately, most of the multidisciplinary meetings – especially those which must produce some critical **decision** on practical projects – are merely confuse and confusing caucuses. Long debates may lead only to deep and damaging misunderstandings, due to the lack of a common conceptual **language** and an integrated view of the system to be managed (ACKOFF's *messes*)" (Ibid).

Thus, while the multidisciplinary approach is obviously a practical necessity, it may at the same time be clearly insufficient and in dire need for a systemic **transdisciplinary language**.

2220

MULTIDISCIPLINE GROUP^{1) - 4)}

"... a group of people who together possess all specialized skills necessary to perform the **operations** confronting them" (J. JOHANNESSEN & A. HAUAN, 1992, p.174).

About such groups, the authors emphasize that: "The main idea, however, lies not in the **design** of the group but in its functioning".

The MDG is useful only if its participants possess and use "**communication competence**", which allows for fruitful **interaction** and opens the possibility of **interactive planning** through **participative design**.

2221

MULTI-EQUILIBRIUM²⁾

Characteristic of a system which possesses various equilibrium points and is able to switch suddenly from one of these to another.

Each of these equilibrium positions is a punctual **attractor** and the **transitions** between them are the different elementary **catastrophes**.

The system can generally switch back to former positions. Each equilibrium position is characterized by a different **behavior** of the system.

→ **Ergodicity**

2222

MULTIFINALITY¹⁾

The possibility for a system to reach different final **states**.

Of course, a given system does reach only one final state, selected from the set of all initially possible ones through the successive specific conditions it encounters in its **environment** during its **history**.

→ **Equifinality**

2223

MULTIFOCALITY^{1) - 2)}

An organizational way "...characterized by numerous centers or foci of likely **interactions**, spread through an area, each focus being as far as possible self-sufficient" (S. BOYDEN, 1978 – quoted by W.D. GROSSMANN and K.E.F. WATT, 1992, p.8).

These authors state: "In a multifocal system, the **breakdown** of an **element** or of a whole focal point will not really affect the rest of the system because of the self-sufficiency of the **subsystems**" (p.9).

This may be over-optimistic, since the **breakdown** may affect a really critical **subsystem** (for instance the one securing **energy inputs**), but nevertheless it is generally a good bet. Multifocal systems however still need global **coherence**, **monitoring** and **regulation**.

Multifocality is closely related to **heterogeneity**.

2224

MULTILECTICS^{1) - 3)}

An intellectual **methodology** for the study of "qualitative **transformation processes** in which there are three or more systems that interact **synchronously**" (R. RODRIGUEZ DELGADO, 1991, p.8).

Introducing this neologism RODRIGUEZ DELGADO states: "**Processes of change** and qualitative **transformations** are not **linear**. In **complex systems** – individual and social – many **inputs** enter by different ways and are elaborated in many forms. Some **inputs** are preserved in **memories**. Multiple **outputs** impact on different **environments**. Therefore the **triadic** logical **structure** of dialectics appears as a **methodology** that can be useful only in some extreme cases" (p.8).

2225

MULTI-LEVEL DESCRIPTION^{1) - 2)}

The **modelization** of a complex system taking in account the different identifiable levels with their corresponding **subsystems** and the **interactions** between levels.

The best tool for multi-level description is J.G. MILLER **taxonomy of living systems** (1978).

For **ecosystems** H.T. ODUM offers useful tools (1971, 1976, 1983).

2226

MULTI-LOOP MODEL²⁾

A **graph** of interconnected **elements**, quantitative-qualitative **variables** or **concepts** representing some system.

M. MARUYAMA introduced these models in order to represent multi-loop **mutually-causal systems**. (1968, p.81-2).

Each **node** in the **graph** is connected in a selective way to some others by **in-** and **out-branches**. Of these, some represent **positive** and **others negative feedbacks**. **Flows** may circulate continuously, or not, between the **nodes**.

Models of the same kind have been widely used by J. FORRESTER in his **Systems Dynamics**.

Of course, the usefulness of these models depends on an accurate evaluation by the **modeler** of the **elements** to be integrated as **nodes** into the model, and of the characteristics attributed to the **branches**.

2227

MULTI-MODAL SYSTEMS THINKING¹⁾⁴⁾

V.DE RAADT writes: "Multi-modal systems thinking is a normative approach to systems science that draws from both conventional systems science such as that developed by von BERTALANFFY and his successors, and from DOOYEWEERD's theory of modalities"

"The aim of multi-modal systems thinking is to reform and expand science so as to add the norms of human life to our **understanding** of the determinative part of life. These **norms** address all areas of our life, including such things as marriage and child rearing, work, service to others, preservation of our heritage, **learning**, and ethically following our religious, cultural and social pursuits"(2001, p. 4)

Such a proposal seems to cover a basic-but widely forgotten-need, in western societies in particular. However, it implies the adhesion to specific **values** and norms **proper** to a specific **culture**.

There is probably a need to harmonize understanding of the values and norms systems across all **cultural systems** in order to avoid clashes between them, as a result of divergent **beliefs**

This will probably imply the arduous task of creating a **frame** of meta-**values** and meta-norms acceptable for all cultures and **rules** about transcultural reciprocities and respect

The most difficult issue is probably how to handle the seemingly natural intolerance frequently associated with strong unilateral belief.

→ **Methodology (Multi-modal systems)**

2228

MULTI-PERSPECTIVISM¹⁾²⁾⁴⁾

The most dangerous challenge that mankind will have to meet during the 21st C. is the growing confusion in all kinds of **issues**, worldwide.

A very sketchy sampling of these is as follows:

- the anarchic **growth** of megalopolis and the resulting numerous and intractable problems of most varied kinds
- the growingly complex ecological problems, turning evermore global (atmospheric pollution, water crisis, possible climate change, waste accumulation, etc.)
- the worldwide massive demographic **explosion**, possibly starting now to turn into an **implosion**
- terrorism, **anarchy**, warfare and massive corruption spreading in all continents
- growing hostility between some **cultures**
- foreign debt and financial crisis in many countries

All of these issues are known, but merely in a superficial ill-connected way. Their **interrelations** are ignored or ill understood.

This **situation** is now emerging in the **consciousness** of a growing number of people and systemic multi-perspective **models** are starting to appear.

H. BENKING, for instance, advocates the need to make a wide-embracing "**know-map**", in a coherently organized fashion, in order to become able to find the specific **information** we need (but within **context!**), and even possibly to discover more precisely what to look for". In this way, every "player" would know better where he is located in the general **frame** of **events**, with whom to start a **conversation** and eventually what to do and how to do it.

Benking adds that we do not only need a "good map", but also a compass to orient us when using the map and find (or become oneself) a good pilot in the cybernetic sense.

Other important proposers of multiperspectivism are:

- A. JUDGE, general secretary of the Union of International Associations (Brussels) who publishes an Encyclopedia about world problems and world **resources** to solve or manage them: <http://www.uia.org/uiadocs/aa-docdia.htm>
- The **Club of Rome** interconnected World Models, based on Forrester's **Systems Dynamics**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- J.de ROSNAY, who proposed his "**Macroscop**" as an integrative and also multiperspectival view of **wholes**
 - the "Systems Reasoning **Paradigm** of the Information **Image** and Nature" of M. BACEWICZ (Polish Systems Society at Wroclaw Technological University)
 - B.H. Banathy, J. WARFIELD, and I. MITROFF and H. LINSTONE's work on **Design** are also important contributions
- **Eco-cube/know map; Panorama; Scholasticism; Underconceptualization**

2229

MULTIPLE PERSPECTIVE METHOD ^{1) - 2)}

The use of different perspectives to study and manage some issue, **situation** or system.

Multiple Perspective Method has been proposed by I.I. MITROFF and H.A. LINSTONE (1993, p.97-108).

They propose three interconnected perspectives:

"T. The Technical Perspective.

O. The **Organizational** or Societal perspective.

P. The Personal or individual perspective." (p.99)

The authors define as follows the following key characteristics of their method:

"- The system **designer**, analyst or manager is a fundamental part of the system or **problem** being analyzed.

"- The **choice** of which particular perspectives to bring in a specific **problem** or to emphasize is a matter of one's ethical **values** and judgments, even though all complex **problems** invariably involve all three perspectives.

"- The value in using multiple T, O, and P perspectives lies in their ability to yield unique insights. None by itself suffices to deal with a **complex system**, but together they give a richer base for **decision** and **action**.

"- Any **complex problem** may be viewed from any perspective.

"- O. and P. differ in fundamental key characteristics from T. As a result, O and P inexorably move us beyond those features associated with basic science and engineering.

"- In the Multiple Perspective concept, we also cannot prove that a **set** of perspectives is the "right" **set**.

"- Two perspectives may reinforce one another or cancel each other: frequently they interact in a dialectic **mode**.

"- A perspective may change over time.

"- It is not easy to distinguish between an O and a P perspective: is the person giving his or her own or the **organization's** perspective?

"- In "real-life" **situations**, managing **problems** consists of at least three activities:

- a) analyzing alternatives,
- b) making **decisions** about which alternative to choose

c) successfully implementing the chosen alternative.

The T perspective focuses most strongly on (a) and least on (c); hence the gap so often deplored between analysis and **action**".

(For more exhaustive information, see reference)

Multiple Perspective Method is obviously part of a general systemic **methodology** of **problems management** and **systems design** presently forming.

2230

MULTIPLICATION ²⁾

"The **relation** of joining the **parts** so as to involve them with each other" (J. FEIBLEMAN & J.W. FRIEND, 1969, p.433).

This definition does not appear quite satisfactory in the sense given to it by FEIBLEMAN and FRIEND, as it implies an idea of **interrelation** of **synergetic** or *co-structural* type.

This may be seen clearly in the example they give: "The relation of skin, flesh, and seeds in a whole apple is multiplicative rather than additive because these **parts** are involved with each other in ways other than mere **aggregation**. (p.33)". The skin does not multiply the seeds, nor conversely.

One could understand that multiplication is an additive mode of **elements** or **parts of the same, or different** types, not any more under the guise of simple **aggregates**, as in **composite systems**, but as **structures**. For example, an increase in the number of clerks in an accounting service in a growing business may or may not increase the **complexity** of the accounting **subsystem**. But it generally does.

Eventually it could introduce the need for a new **control subsystem**, if the accounting division becomes too numerous and difficult to manage.

2231

MULTIPLIER (Social) ⁴⁾

The **effect** of enhanced collective **performance** on the performance of individual members of the group.

According to W.T. DICKEY and J.R. FLYNN (2001, p. 45-7) in human **groups** the betterment of the general performance of some kind produces an **environment effect** through **feedback** on the participant individuals. Those in turn, by enhancing their personal performance because they are thus stimulated, tend to positively affect the general performance of the **group**.

For ex. a society where the level of **knowledge** is increasing would incite the individuals to increase their personal **level** in order to avoid losing their **value** in relation with the global **activity** of the group.

Moreover this **effect** is becoming reiterative and accumulative and leads in turn to an increase of the general **level** of the group.

2232

MULTIPOLE ²⁾

"A more complex **black box** equipped with a certain number of **input** terminals of the same or different kinds" (M. BUNGE, 1979, p.254).

Compare with the "**dipole**", the simplest **black box**.

2233

MULTISTAT ²⁾

"A system formed by stable **subsystems**, associated through more or less lax **interrelations**".

As defined by B. WALLISER (1977, p.62), the difference with ASHBY's **homeostat** does not seem evident. WALLISER uses the concept to describe ecological **interrelations** between multiple species, or in economy to describe **constraints** between production and consumption.

2234

MULTIVERSE ¹⁾

A **consensual** vision and understanding of some **part** of the **universe**, obtained by a **group of observers**.

The concept has been proposed by H. MATURANA, within the frame of his physio-psychological study of the limits of **perception** and conceptualization, which led him to his "constitutive **ontology**".

It can be connected with G. JUMARIE **relativistic theory of information** (1980).

Moreover, according to MATURANA, also every individual lives in a multiverse (1988, p. 31, 1997), in accordance with the different selected **domains** of his/her experience, as for example scientific research, music, games, etc.

As expressed by J. MINGERS: "This appears to be close to SCHUTZ's (1967) ideas, within **phenomenological** sociology that individuals experience their lives within finite provinces of **meaning** and that consequently there exist multiple **realities**" (1990, p.577).

Of course, this view is a consequence of accepting only, or at least, to prefer, the subjective **meaning** of "**reality**".

2235

MUSIC FROM A SYSTEMIC VIEWPOINT ¹⁾

Musical works can be viewed from two different angles.

In the first place, a musical work has normally a **structure** defined according to certain **rules** of the art. For example, it can be western tonal music, or dodecaphonic, or jazz. Or it can follow the rules of the Indian Ragas. All these rules also imply typical **dynamics**.

Tonal music for instance has been thus described by LERDAHL and JACKENDORFF (1983) and by E. CAMBUROPOULOS in 1998

On the other hand, music is made to be perceived by auditors. While specific musical **perception** has not been widely researched, it is obvious that the people that we consider as musically "educated" are these who assimilated specific **frames of reference** corresponding to the acoustical nature of sounds and their combinations and/or the **rules** corresponding to a specific type of music (for ex. tonal or dodecaphonic rules of musical composition) (I. DELIEGE, 1999)

→ CASIS Journal, v.4, 1999, which contains 14 papers on music structures and perception

2236

MUTATION ¹⁾

A **structural, functional** and/or **behavioral change** affecting a **subsystem** or a system and, eventually their **interactions** with their **environment**.

Deriving from the biological **meaning** of the concept, in **systemics** it could be extended and modified: Any mutation affecting one **element** or **component** would normally induce a new general **structural** and **behavioral accommodation** of the system as a **whole** and **structural** and/or **functional** modifications of some of its **processes**.

Mutations may also have consequences for the **relations** of the system with its **environment**, provoking for instance modifications in its ethological **behavior**. It should be sometimes difficult to find out if **behavioral change** precedes or succeeds mutation and how is exactly the reciprocal **causal relation** between both.

2237

MUTUALISM ⁵⁾

A kind of complex **symbiosis** in **ecosystems** with numerous heterogeneous **components**.

Pollination by insects tends to maintain vegetal species which are necessary for the **survival** of the insects themselves as species. The same effect connects animals which bury seeds of the plants they eat, for example squirrels making stores of acorns.

There is also a kind of negative mutualism. Some trees defend themselves against insect

pests with biochemical emissions... and some pests even circumvent these defenses by enzymatically detoxifying these poisons... while the plant's emission acts as a call for the parasite's parasites! (P. GREIG SMITH, 1986; J.F. DOBRE-MEZ et al, 1995, 912-16).

Such natural **controls** are more than once destroyed by ill-advised human interventions, as for example the inadequately timed use of pesticides which kills not only the parasite, but altogether the parasites that could maintain them in check.

Mutualism is also a **relationship** between two **organisms**, which is beneficial for both.

For example, some trees obtain nutrients from fungi living on their roots. The fungi in turn obtain carbohydrates produced by the leaves of the tree

(It seems that some authors consider this collaboration as symbiosis)

Finally, mutualism may also exist among groups, as for example as reciprocal protection in fish **shoals**, or in herbivorous herds (zebras, antelopes) in which all members benefit from the collectively fostered vigilance against predators.

→ Commensalism; Cooperation; Herd effects; Parasitism; Stigmergy; Symbiosis

N

2238

NARRATIVES ¹⁾⁽³⁾⁽⁵⁾

An hypothesised capacity of the **brain** to construct more or less coherent histories about our successive experiences with the outside world (J. GRAY, 2002, p. 48)

This would be a typical **autopoietic process** and a general aid for **understanding** and subsequently coherent **action**.

This narratives upbuilding would seem to start very early in the brain of the baby and be a condition for further mental and psychic **development**.

It is very probably connected with the concept of "internal language" as developed by some psychologists.

And of course, no narratives could be expressed without a language. This introduces cultural **constraints** into the ways the narratives are constructed and evolve from childhood to maturity, as a **holistic** integrating process (L. VYGOTSKY; J. PIAGET)

According to M. GAZZANIGA it is the left hemisphere of the **brain** that "makes sense"

for us. It must thus be the origin of the narratives (J. GRAY, p. 49)

2239

NASH EQUILIBRIUM ²⁾

"A combination of **actions** by a **set of agents** such that, for each **agent**, granted that the other **agents** do not alter their own **actions**, its **action** is **optimal**" (S. KAUFFMAN, 1993, p.240).

However, John NASH, who first stated this rule around 1950, proved "that every game reaches a **state of equilibrium** where none of the players can improve his position.

Anyhow, according to KAUFFMAN, this **theory of games rule** has been used by J. MAYNARD SMITH as a **model** for an evolutive **strategy**.

"NASH (1950)... showed that in a "game" with any number of rational players who may have different aims but have full **knowledge** of the others' **actions**, there is at least one set of **strategies** which lead to an outcome where everyone's **aims** are fulfilled as nearly as possible" (Ch. ARTHUR, 1994, p.6))

"The Nash equilibrium was the mathematical basis for the nuclear standoff adopted by the major world powers from the 1950's onwards" (K. Devlin, New Scientist, sept.5, 1998, p. 48)

P. BAK observes however: "In the past, it has often been more or less tacitly assumed that large systems, such as those we find in biology and economics, are in a stable balance, like the sand on a flat beach. The leading economic theory up to now, the **general equilibrium theory**, assumes that perfect markets, perfect rationality, and so on bring economic systems into stable Nash equilibria in which no **agent** can improve his situation by any **action**. In the **equilibrium state**, small **perturbations** or shocks will cause only small **disturbances**, modifying the **equilibrium state** only slightly. The system's response is proportional to the **size** of the impact: **equilibrium systems** are said to be "linear". **Contingency** is irrelevant. Small freak **events** can never have dramatic consequences" (1996, p.28)

These assumptions must be considered sometimes as unrealistic and economic theories, for instance should be revised accordingly, in view of the deep technical and social evolution, worldwide.

The **rule** remains true as long as the basic conditions of the game do not change. In ecosystems this could explain the-at least theoretical- possibility of a climax.

But of course, environment change or mutations frequently alter the basic conditions.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2240

NATURALISM ¹⁾³⁾

"The **belief** that all human faculties are emergent from the rest of nature and not dependent upon some special **operations** of a supernatural agency" (J.Z. YOUNG, 1978, p. 296)

YOUNG adds "Hence in **ethics** the belief that reliable criteria for right **actions** can be founded on factual **observations**, including **facts** about people" (Ibid).

Of course, in the long run, naturalism can be sustained only through experimental confirmation of specific **emergent effects**. Moreover, the very concept of **emergence** implies the appearance of more complex and integrating **phenomena** from so-called "lower" **levels** to "higher" **levels**. Accordingly, the study of this mechanism of **emergence** in itself is also the responsibility of the naturalistic approach, unless we would be back to **reductionism**.

→ **Falsifiability**

2241

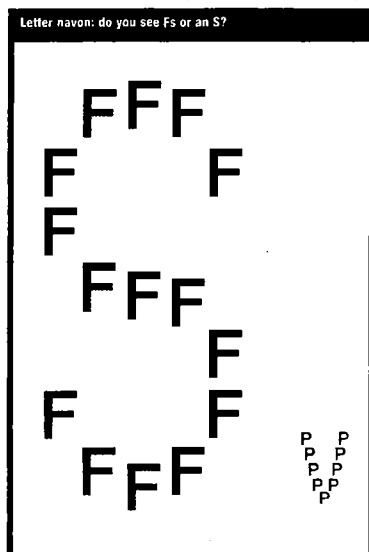
NAVON ²⁾⁵⁾

A picture made of much smaller distinguishable **elements**. (see figure)

The **elements** may - or not - be similar to the global picture. Recently, navons have been used to test the **interactions** between perceptive and high attentional **levels** in the **brain** (J. McCRONE, 1999, p.27)

A navon can be **self-similar** at its two different **levels**.

A beautiful example is the engraving "Public opinion" by the Swiss painter and engraver Arnold BÖCKLIN wherein public opinion is repre-



New Scientist • www.newscientist.com

from: McCRONE, John: "Leftbrain, right brain" in New Scientist, Nr. 2193, July 3rd, 1999

Figure: see entry **Navon**

sented as a gigantic dragon made up of a myriad of much smaller dragons of a similar shape.

Navons present an intriguing perceptive **ambiguity** and has been used to study the effect of alternate **perception** in the brain. However this is a two-way **phenomenon**, i.e. "not a passive **process**. High-level attentional areas can tell low-level sensory areas what they should be concentrated on.

This **feedback** system can suppress the activity of some **cells** and increase the **sensitivity** of others. In effect, the **brain** can highlight what it wants to see"

And "There could still be a wiring bias, formed as the brain develops"(J. McCrone, 1999, p. 27-30)

see figure left column

As a source of **metaphors**, navons are suggestive of the subtle reciprocal **relations** between **levels** within **complex systems**.

→ **Brain circuits; Brain and Environment; Brain organization; Figure-ground; Intentionality; Neuron (Formal); Perception**

2242

NEARLY DECOMPOSABLE SYSTEM

→ **System (Nearly decomposable)**

2243

NEEDS ¹⁾

The basic requirements for a system to maintain its **identity** and **level of organization**.

E. LASZLO presents in a **hierarchic** form an "exclusive categorization" of needs, based on A. MASLOW's work. (1974, p.45).

This **hierarchy** is reproduced hereafter, but subdivided according to the growing order of **complexity** of the concerned **living systems**

- All living beings
- "Safety needs (protection from weather, other species)
- Social animals
- "Belongingness and love needs (family and social **group** membership)
- Humans
- "Esteem needs (having the respect of oneself and his/her peers in society)
- "Self-actualization needs (fulfilling one's potentials in his/her public and private capacity)
- "Cognitive needs (understanding one's relations to society and comprehending order in nature and the cosmos)
- "Aesthetic needs (perceiving beauty and order in experience)"

There seems thus to exist an **evolution** of needs toward progressive differentiation and **complexity** in **dynamic systems**, very probably related to the progressive **complexification** of the **brain**.

2244

NEGENTROPY ^{1) - 3) - 5)}

The measure of "quality or grade of **energy**" (L. BRILLOUIN, 1962, p.116).

Negentropy is, of course, the opposite of **entropy**, and represents the **availability** of useful **energy**.

It is also the opposite of **entropy** taken as statistical uniformity (so-called **disorder**). Negentropy can thus be interpreted as a measure of **order**. This led BRILLOUIN to connect the concept of negentropy with the existence of **information** (see **in-formation**).

BRILLOUIN writes, for example: "Whether he be a **Maxwell's Demon** or a physicist, the **observer** can obtain a **bit** of **information** only when a certain quantity of negentropy is lost. **Information** gain means an increase of **entropy** in the laboratory. Vice-versa, with the help of this **information** the **observer** may be in a position to make an appropriate **decision**, which decreases the **entropy** of the laboratory. In other words, he may use the **information** to recuperate part of the loss in negentropy, but the over-all balance is always an increase in **entropy** (a loss in negentropy)... This leads to the conclusion that both quantities are of similar nature" (1968, p.161).

The subject is however, as BRILLOUIN himself emphasizes, a thorny one: Negentropy cannot be simply equated with **information**. For a thorough discussion see BRILLOUIN's and SHANNON & WEAVER's works.

K. KRIPPENDORFF evaluates the term as "a non-recommendable near synonym for **information**. (It) has created considerable confusion suggesting that **information processes** negate the **2d. law of thermodynamics** by producing **order** from **chaos**" (In view of the recent development of "**chaos theory**", KRIPPENDORFF would now possibly write "**disorder**". He proposes as a "meaningful interpretation of negentropy... that it measures the **complexity** of a physical **structure** in which quantities of **energy** are invested, e.g. buildings, technical devices, **organisms** but also nuclear reactor fuel, the infrastructure of a society" (1986, p.52).

From a more specific systemic viewpoint, V.G. DROZIN wrote: "... negentropy is a measure of **complexity** of a system expressed in the number of its **parts** or **subsystems** and in their **variety**" (1975, p.9). This seems somehow insufficient: **constraints** over **interrelations** also are aspects of negentropy taken in this sense.

2245

NEIGHBORHOOD ²⁾

The **set** of all the points that surround a given point and are close to it.

Such a definition implies the necessity to define closeness in each specific case. Moreover, we also must decide if the points (or **elements**) that constitute the **boundary** of the neighborhood are or not **parts** of it.

This topological concept is important for the formalized **description** of systems and **sub-systems**. Also, **stable attractors** define neighborhoods, out of which a controlled **function** cannot normally escape.

("Vicinity" is also used)

2246

NEOTENY⁵⁾

The conservation in an adult organism of **embryonic** or juvenile biological **structures**.

One of the most curious case of neoteny has been observed in the mexican salamandra axolotl (*Amblistoma tigrinum*) that is able to reproduce itself at the larval state.

It has been conjectured that humans are neotenic anthropoids. If so, neoteny could be an evolutive **mechanism** through a longer maintenance of adaptive plasticity.

→ **Heterochrony**

2247

NERVOUS SYSTEM¹⁾⁵⁾

The study of the nervous system, specially in the human being, is obviously basic for the **understanding** of our **behavior**, our ways of thinking and our social **relationships**.

It is thus very significant for cybernetics and systemics. It is however not possible to develop the subject within the **frame** of this Encyclopedia (whose editor moreover is in no way competent to do it, even if he may have useful general **information**)

Only some more specific topics are presented in this work because of their seemingly central importance, but still in a very sketchy way. Among them are:

- the various entries about the brain
- frog's eye experiment
- HEBB's rule and reinforcement
- hippocampus
- learning as cerebral differentiation
- learning matrixes
- neural network
- neuron
- neuron (formal)
- synapse

Also closely related to the subject are:

- autopoiesis
- closure (organizational)
- constructivism and constructivist cybernetics
- coupling (structural)
- hypercycle
- intentionality (perceptive)
- memory
- model building
- observability, observation process, observer

- parallel distributed processing
- the various entries on perception
- reference frames
- synaptic weights

2248

NESTED INTERVALS²⁾

A sequence of intervals entirely included within a larger interval.

For example, the values of the terms of a convergent series are included within a maximum and a minimum value. Curves may also be nested: For example an **oscillation** between n and $n+1$, could be contained within an **oscillation** between $n-1$ and $n+2$.

→ **See also: Self-similarity in WEIERSTRASS function**

2249

NESTED SET²⁾

Any **set** which is contained in another **set**.

This is a rigorous condition in **hierarchies**, when every **element** of the lower **order set** must be included within the higher one.

2250

NESTING PRINCIPLE^{1) - 3)}

Any unit becomes, or is **embedded** as a **part** in some more global unit.

The principle is basic to J.J. GIBSON's way to understand **levels of perception**. In his words: "The smaller units are **embedded** in the larger units by what I will call *nesting*. For example, canyons are nested within mountains; trees are nested within canyons; leaves are nested within trees; and **cells** are nested within leaves. There are **forms** within **forms** both up and down the **scale of size**".

As a result: "The unit you choose for describing the **environment** depends on the **level** of the **environment** you choose to describe" (1986, p.9).

This is one more expression of the quite general **perception** of **levels of complexity**, very basic for any **systemic description**. The concept, which offers a dynamic as well as a static aspect, is closely related to those of **criticality**, **embedment**, **fractals**, **niche**, **subsystem**, **suprasystem**, **wholes** and **parts**, etc...

2251

NET²⁾

A **structure** including a number of **elements** and the **interconnections** among these **elements**.

Any net includes a limited number of **elements** and of **interconnections** as permitted by the existing **constraints**.

It distinguishes itself from its **environemnt** by the great number of its internal **interconnections** in comparison to the quite more reduced number of its external **connections**. It may become integrated in a **hypernet**. In that case, it is sometimes called a "subnet".

The **elements** in the net take their **decisions simultaneously** according to what they know about the global **state** of the net at that moment.

→ **Communication**

2252

NET (Access problem in a net)²⁾

In a parallel processing net, numerous independent **programs** need to communicate in a coordinated way. However they need also to obtain access to those **parts** which are of common use for the **whole** system and thus start to compete for general **memory** facilities or peripherals time.

J.P. SANSONNET writes: "(As) these interactions are asynchronous, this turns unpredictable their global **behavior**... It may happen, for example, that different tasks compete for common **resources** in a disordered manner and in this way very quickly critical situations appear, such as those called "Famine", or "Fatal embrace".

"Famine: Some tasks never obtain the **resource** they need - for ex. never accede to the printer to produce their **output**.

"Fatal embrace: Two tasks wait indefinitely for each other" (1988, p.1304).

Organizing the net and making compatible its interconnections is thus a fundamental requirement for correct and efficient **operation**. SANSONNET writes that, to avoid access problems "each processor may be endowed with some local **memory**. Each pair **processor/memory** thus becomes a small and relatively independent computer" (p.1303).

It is noteworthy to observe, when **simultaneity** replaces sequentiality, how the need for general **organization rules** pops up immediately.

→ **Contention; Parallelism; Processing: simultaneous or sequential; transputer**

2253

NET (Connection modes in a)

→ **Connection modes**

2254

NET (HYPER-)²⁾

A net including a number of lesser nets

In general, the hypernet defines the **connections** among the integrated **nested** nets and controls the **connections** with the global **environment**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2255

NET (NESTED)²⁾

A net contained entirely within another net.
Also sometimes called "subnet".

Generally various **interconnected** nets are included within the **global net** and some **communication** is possible among a number of **elements** pertaining to the different nets.

2256

NET Stabilization^{2) - 3)}

L. PERSONNAZ et al., who study the **learning process**, in relation to the network **model**, write on this topic: "If the **learning process** is correctly conducted, the **energy function** of (such) a net takes minimal values precisely for these **configurations** which have been presented to the net during the **learning process**." (1988, p.1369).

The **learning process** thus *defines* the net: This is equivalent to the "Lern-Phase" in **Steinbuch matrixes** (but in a more elaborated way).

The authors moreover state: "In other words, the net did compute its synaptic **efficiencies** in such a way that these **configurations** that it must memorize are minimal **energy stable states**,... **attractors** in the net's **space of states**." (p.1370).

The net thus reaches the minimal **level of entropy** production compatible with its specific nature.

2257

NETWORK^{1) - 2)}

A **structure** of **communication** links that allows for exchanges of **energy**, **matter** and/or **information** among the **elements** (**processors**) or **subsystems** in a system.

Basically, networks are: a) combinatorial, according to **rules**;

b) **auto-catalytic** by spontaneous construction of functional **cycles**.

Normally, each **processor** acquires a specific **activity**, i.e. specific links with other **processors**, which either act upon it, or are acted upon by it. This is why networks are easily represented by **graphs**, and particularly, oriented ones.

As noted by J.A. GOGUEN and F.J. VARELA, the network **model** is closely related to the concept of **recursion**, but in opposition to the restricted vertical concept of **hierarchy**: "The reciprocal **connectivity** of a **net** suggests the **coordination** of a system's **elements**; a **tree structure** suggests the sequential subordination of a system's **parts**, each **part** having its own well defined **input-output behavior description**". Consequently, these authors define a network as "a directed **graph**" (1979, p.36).

Any network must be pre-defined by appropriate **constraints**, i.e. a selection of the actual or potentially useful **links**, excluding those who should not be significant for a proper working of the system.

L.H. KAUFFMAN states: "A slight **disturbance** creates conditions of local imbalance through the net. The net preserves itself by correcting these imbalances, but in the **process** may create further imbalances" (1977, p.179) and... "... networks... are characterized by a **self-referential interdependence of parts** and the **whole**. The **behavior** is a matter of balance among the **parts** and the preservation of this balance under internal and external **perturbations**" (p.187).

Starting with an initial **situation** and quite simple **rules**, many systems generate themselves by constructing their own **intercommunication** network through a progressive **process of trial and error**, applied to successive **inputs**. See: "**Genetic algorithms; order from noise; Boolean functions**".

Conversely however, networks are difficult to program in the habitual sense, because the introduction of a ready made **algorithm** should inhibit their self **training** ability.

On the contrary, **processes** of self-**training** appear to be at work within the learning **brain**, the **perceptron** and the more recent so-called neural computers, as well as societies (human, ecological, and probably of robots in a not too distant future)

Nets **elements** work in **parallel**. Thus, at the same instant, many different **events** happen within the network. This leads to **chaotic determinism** in the **behavior** of the system.

A network has generally very numerous potential **states** implicit in the multiple possible combinations of its **elements**.

St. KAUFFMAN states that "Because all the **elements** act simultaneously, the system is... said to be **synchronous**. A system passes from one unique **state** to another. The succession of **states** is called the **trajectory** of the network" (1993, p.66).

Moreover networks have a *finite* number of **states**: "A system must therefore eventually reenter a **state** that it has previously encountered" (Ibid.).

This should possibly be somewhat qualified: Very **complex systems** have so many possible **states** that they may practically never reenter again a former **state**, while however some of its stable **parts** ("**frozen cores**" in KAUFFMAN's terminology) may do.

Once the network is organized, i.e. has acquired some specific **function**, this **function** responds to a **matrix of state transitions**.

Closely related subjects are: "**Connectionism**", "**Constructivism**" and "**Neural networks**".

2258

NETWORK ANALYSIS^{2) - 4)}

"A **planning** technique... used to plan and control complex projects, especially in the construction and engineering industries" (I.G. BLOOR, 1987, p.32).

There are different versions of this technique (see for ex. **P.E.R.T.**). In all cases, a global **space-time graph** of the successive projected tasks is established in view to define orders of priorities, compatible **simultaneities**, **time** schedules; to select the best **combinations** and to evaluate relative **costs**.

The technique requires a global view of the considered project and of its general **environmental** conditions, the present and as much as possible, the future ones.

2259

NETWORK and PARTS^{1) - 2) - 4)}

No part in a network is able to understand fully the network. This is the case for everyone of us, as an **element** of social networks of different kinds. We may only form working hypotheses about any network of which we are part.

Networks acquire **emergent** properties. H.T. ODUM writes: "The network of society has a form of thinking since it is a computer network in itself, quite over and above those it encompasses - the electronic computers of industry and the even more remarkable computer, the mind of man" (1971, p.245).

The **metaphor** could be somewhat overstretched, but in due time it may prove correct... and is in any case suggestive.

H.T. ODUM adds: "The network is doing things to keep itself regulated, adapted, and consistent with energetic laws that the individual cannot envision" (p.245).

2260

NETWORK BEHAVIOR^{1) - 2)}

R. ROSEN observes: "... the essential thing... is that the behavior of (such) a network is always the outcome of an **interaction** of pairs of antagonistic **activities**, one of which excites a particular **response**, and the other inhibits it" (1974c, p.171).

ROSEN uses the terms "**inducer**" and "**repressor**" to name such paired but antagonistic **processes**.

Thus the network behavior is basically **digital**, or **binary**, even if this aspect may be quite obscured by the numerous simultaneous **interactions** that constantly occur.

From another angle, it seems that natural networks, as for instance a river basin, or a system of geological plates, are globally able to minimize their **energy** expenditures, in accordance with some few implicit **optimization rules**. (YAM, 1994, p.17). This recently discovered and intriguing feature is still under investigation.

2261

NETWORK (Boolean formulation of a)

→ Boolean formulation of a network

2262

NETWORK (Causality in a)^{2,4)}

Causality in a network is kind of distributed.

Each **element** is a **causal agent** in its own right. It is however constrained in its **behavior** by the **inputs** it receives from the other elements. And in turn it will constraint the behavior of those elements which will receive its **outputs**.

Moreover, not all elements will receive or emit directly to each others. Some may even never receive some types of inputs. In such cases, specific **localizations** may appear in the network. This is possibly a **model** in the case of the progressive **organization** of the **neural network** in the **brain** (see "neurode"). On the other hand, no **transmission** is instantaneous and the resulting **time lags** will insure different conditions in different places in the network, as a result of differential spatial and temporal **propagation of effects**. In this way, the general **determinism** of the network can be somewhat disrupted locally.

A result is that any network will readapt permanently, somehow in the way of ASHBY's **homeostat**.

However the general behavior of the network would remain within the global - but lax - **constraints** imposed to the network either by the **context**, or by its constructor (in this last case, for ex. by a **back propagation algorithm**).

This model of network **causality** could possibly be also useful for research on complex social **interactions** in human **groups**.

2263

NETWORK: Described as a graph²⁾

St. BEER writes: "... the most useful scientific **language** for discussing ... networks... is really the theory of graphs..."

"... the graph as a logical entity, consisting of an arborescence of **binary relations** (is) to be treated by **Boolean functions**. Now, the modern mathematical statement of graphs is achieved with the help of the theory of **sets**, and it looks like subsuming all the other **descriptions** in one. (The **vertices** of a graph are regarded as **elements** of a **set** which is mapped into itself, of which **set** the whole graph is then a multi-valued **function**)" (1968, p.218).

Three different, but related, graph **descriptions** of a network can be thought of:

- The static "vertical" arborescence representing a supposedly invariable **hierarchy** (Example: the structural **representation** of an **organization**);

- A dynamic "horizontal" arborescence, representing the **flow lines** of the interconnected **variables** of the system in **time** (Example: **Critical paths** graphs);
- A closed **cyclical** graph, also allowing for the **representation** of the **dynamics of feedbacks** between **elements**. (Example: M. EL-GEN's **Hypercycles** graphs).

2264

NETWORK DIAGRAM²⁾

A global **representation** by a **graph** of the **flows** within a network.

Flows circulate from some compartments or boxes to others within the network. As an organized network is defined by specific **constraints**, not every compartment is communicated directly or indirectly with all other compartments.

H.T. ODUM states: "The number of possible boxes and the number of boxes actually utilized in the system are properties of the **complexity** of the network" (1971, p.37-8).

Quantitative **representation of flows** is better done through a **matrix**, which is however more abstract.

2265

NETWORK (Evolutionary)²⁾

"...an assembly which acts as the immediate **environment** and the material substance of an evolutionary system" (G. PASK, 1961, p.82).

According to PASK: "The network itself cannot be said to evolve (its possible **states** are always evident). On the other hand, the **active region** in the network which is the **system** we refer to as 'learning' does evolve" (Ibid).

Any network that is able to increase or modify its internal **connections** is a **learning system**. It should however seem better to distinguish "learning" from "evolution".

The basics of the subject was thoroughly explored as early as 1960 by G. PASK and H.von FOERSTER in their paper on "A predictive **model for self organizing systems**" (1960-61)

It has been renovated since 1985 by the study of the **neural networks** and the **connection machines**.

2266

NETWORK (Hopfield)²⁾

For a good introductory graphical description of this network, see P. DENNING (1992b, p.427-8).

HOPFIELD introduces **nonlinear dynamics** in computational networks. In DENNING's words: "HOPFIELD showed that his network can memorize **patterns** by storing them **directly** into the weights; no **training** is needed. There is a **feedback path** from the **output** of each unit to the **input** of every other unit, and all of these **paths** are assigned individual weights... Ultimately the network settles into a condition of **equilibrium**... If an **input pattern** does not ex-

actly match one of the memorized **patterns**, the network will reach **equilibrium** at the nearest memorized **pattern**. This **behavior** provides a means for restoring a **pattern** from a noisy or a partial version" (Ibid).

HOPFIELD's networks are somehow reminiscent of ASHBY's **homeostat**.

2267

NETWORK (Learning)^{2) - 4)}

G. PASK states that learning networks (which are **self-organizing systems** - see above Network, Evolutionary) need "...input **filters** which must be able to detect **arbitrarily chosen attributes**". (1961, p.86). In the case of the **brain**, for instance, those arbitrarily chosen **attributes** are selected through the sense **organs**: we are able to register red or blue light, but not infrared or ultra-violet one. Moreover, we must be able to pick up **distinctions** as for example differentiate red and blue, or in natural **languages**, specific sounds: a, i, u. (Characteristically, these written **signs** represent *different sounds* in different **languages**).

PASK observes moreover: "In our social **environment** we learn, not new **attributes**, but the yen to regard certain values of the **attribute** as identical" (Ibid).

Thus, the English sound 'a' is different from the French 'a' and, even from the Australian or North-American one. What one hears or sees is what one has been culturally trained to hear or see, within the basic genetic **determinism** of human speech or sight sensorial **structures**.

The same must be true - even if in a very different setting - for electronic networks constructed to recognize words or sounds.

2268

NETWORK (Matrix of a)²⁾

The **representation** of the **flows** within a network through a matrix.

The matricial **representation** is complementary to the graphical one, as it emphasizes the quantitative aspect of the **flows**. As stated by H.T. ODUM "The absence of a pathway in the **network diagram** is a zero in the matrix" (1983, p.20).

2269

NETWORK (Parallel- processing)^{1) - 2)}

A network in which "all **elements** compute their next activities at the same moment".

S. KAUFFMAN comments about this type of networks: "If we find order in **random** networks, than **random** parallel networks with **random** logic have **order** despite an apparent cacophony of **structure** and logic" (1993, p.192).

This **order** would be most probably **ergodic**.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

KAUFFMAN also observes: "... the current enthusiasm for **connectionism** and for **parallel-processing neural networks** is precisely that any such system almost inevitably classifies,... has internal **dynamics** whose **attractors** represent alternative **asymptotic states** of the network" (p.233). And the following statement may possibly be considered as another formulation of **autopoiesis**: "The alternative **attractors** in a fixed **environment** from which the network receives **inputs** can be thought of as alternative **classification** of the same **environment**. Similarly, alternative **environments** which **map** to the same **attractor** can be seen as **classifications** of those different **environments** as "the same" by the network. Thus such networks inevitably classify and have internal **models** of their worlds" (Ibid).

2270

NETWORK (Psychosomatic)

→ Psychosomatic network

2271

NETWORK (Random)²⁾

It has been defined as a network in which all **nodes** have about the same number of **links**. However, G. PASK quite to the point, wrote as early as 1961: "I do not condone a lot of loose talk about 'random networks'. Random network should mean a very definite initial **structure** determined by a random number table, presumably because the initial **structure** does not affect those features of **behaviour** that interest us, providing the **behaviour** is averaged over an ensemble of artifacts" (1961, p.84).

A fully random network should not present any **constraint** at all and thus be totally unpredictable, even in the statistical sense of a **Markovian system**. Such a network could not learn, not lead to any **organizational closure**... and, after all, could not be a network at all.

Practically however, **randomness** is always framed within some determining **constraints**.

2272

NETWORK RESILIENCE

→ Resilience in Networks

2273

NETWORK (Scale -Free)²⁾

A network with many **nodes** with few **links** and a few nodes with many links.

→ Scale-free networks

2274

NETWORKING⁴⁾

The spontaneous **coordination** between **groups** realizing different tasks in a **society** or **organization**.

It has been observed in insect societies (ants, termites or bees) that different **activities**, needed for the global **survival** of the society, become automatically harmonized. When needed, individuals may and do shift from one specialized **group** to another, through a *spontaneous process* of tasks allocation.

Such **patterns** also vary according to the maturity of the society, i.e. tend to stabilize when it reaches **dynamic stability**. See for ex. D. GORDON (1995, p.50-57).

Networking **adjustment** is also quite obvious in human **organizations**, especially in time of **strain**.

2275

NETWORKS AS IMPERFECTLY CONNECTED SYSTEMS²⁾

No working network could be totally and perfectly connected. It cannot be functional without a (limited) degree of leeway, or laxness. As said in terms of popular common sense: "All roads lead to Rome"(or anywhere else, or nowhere in particular)

In such a condition of indefiniteness the network is indetermined and cannot be usefully put to work.

And of course, if there are no **connections** at all between the **elements**, the network does not exist as such.

To become functional it must must acquire a more or less defined **dynamic organization**

It becomes partly determined in such a way when **rules** are introduced, defining a more or less wide variety of possible, but conditional **transitions**, together with other rules defining an **adaptive dynamics** (for ex. **parallel distributed processing**)

On the other hand, the specific conditions of **space** and **time** of the network limit the possible reaches of the rules.

→ **Ecosystems dynamics; Graphs; Homeostat; Inter-influences; Isochronic; Isotropy; Markovian system; Multistat-Network (Parallel Processing); Stability (Poly-); Synaptic weight**

2276

NETWORKS ORDERING²⁾

Networks are, by definition, sets of a number of **elements** and their **interconnections**. This is amenable to factorial **combinatorics**.

When the elements are very few, the number of all possible interconnections is quite limited. For ex., 3 elements can combine in $1 \times 2 \times 3 = 6$ different ways (AB - BA - AC - CA - BC - CB).

However, when elements become more numerous, the number of possible combinations grows inordinately. For ex. for 8 elements, we have

$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = 40.320$ ones. If all these interconnections - or corresponding **interactions** - are admitted, the net loses any specific definition and the number of operations gets out of **control**.

A natural solution is to introduce **constraints** (ASHBY, 1958, 1960 - GREY WALTER, 1953, p.27-28). This can be done:

- by creating a **meta-** (or **hierarchical**) **level** in the network in order to define a reduced number of "blocks" grouping a number of elements with a common **positional value** characteristic of the "block". For ex. A, B and C form a group L; D, E, and F form the group M and G and H form the group N. In this way the interconnection and **communication** problem is again reduced to factorial 3. The **process** can be repeated by creating **meta-meta-levels** and so on.
- by cutting some **links** between some elements., for ex. inhibiting direct **communication** between C and G, between A and F, etc... In this way, the network needs no hierarchical **nodes**. But it needs those constraining **rules**, that must be somehow stated or imposed.

both devices could moreover coexist. This seems for ex. to be the case for the neuronal network in the **brain**. Not all **connections** are possible or effective, and more or less specialized centers of **activity** shape up.

Obviously, **hierarchical** meta-levels signal the **emergence** of increased **complexity**. Meanwhile **inhibition rules** have somehow equivalent effects as hierarchization, with some more leeway. Ashby reformulated these **interconnections rules**, speaking of **richly** or **poorly joined** systems.

2277

NEURAL COMPUTATION^{2) - 3) - 4)}

"The construction of **invariances** by means of neural **mechanisms**" (St. KATZ, 1976, p.44).

St. KATZ adds: "When these **invariances** are assigned a name and given significance or **meaning** within some framework, they become what POWERS calls "controlled quantities" (Ibid).

In other words, the **neural network** constructs its **algorithms**, through its own activity. In psychology, POWERS field, neural computation may be redefined "... as a constructive **activity** occurring *within the subject*" (Ibid).

KATZ observes that the **subject** "... may attach **ontological** significance to the items it knows, (but) those who see the **subject-environment relation** within the framework of neural computation believe differently" (Ibid).

Neural computation can be considered as the root of **connectionism**. G. FERRY writes: "The connectionists...believe that systems can be developed, which, if connected together and endowed with sufficient **complexity**, will automatically process **information** and manipulate

knowledge. Connectionists are strongly influenced by biological systems. These biological **models** give hints about how **information** is stored and then processed in the **brain**". G. FERRY traces back this idea to D. HEBB views about the weighed **flexibility** of neurons **connections** with their neighbours and the **reinforcement** of pathways by continuous use (1986, p.36).

The basics of neural computation could introduce a new concept of **Artificial Intelligence**, not anymore relying on strict **preprogramming**, but based on progressive **training** through numerous examples of **objects** or **processes**, i.e. closer to natural intelligence.

2278

NEURAL NETWORK²⁾

"An array of **processors** interlinked by **connections** that can be strengthened or weakened" (H. COLLINS, 1992, p.40).

(Different types of similarly constructed networks are also known as **connectionist models** or **machines**, artificial neural systems or **distributing parallel processors**)

P. DENNING explains: "Neural networks are **structures** consisting of highly interconnected elementary computational units. The networks **map input patterns**, are encoded as vectors of **bits**, into **output patterns**. They are called *neurons* not because they **model** the nervous systems of animals but because they were inspired by them. Most authors do not emphasize the biological **metaphor**: they talk of units and **connections** rather than neurons and synapses" (1992b, p.426).

R. ROSEN offers the following short synthesis about the origins of neural networks **models**: "They were initially introduced by McCULLOCH and PITTS in 1943, as discrete, **Boolean** versions of the continuous-time dynamical network introduced earlier by RASHEVSKY (1960, p.230-41) and his collaborators. Technically the passage to **discrete time** served to sidestep the then insuperable analytical problems arising from the systems of **nonlinear** differential equations which characterize the continuous-time case: the study of neural **nets** requires only algebra and **combinatorics**. It quickly became clear that the neural networks not only furnished key insights into the **operation** of the **brain**, but also indicated how one might fabricate new systems which could behave in a brainlike fashion. Consequently, neural networks became one of the primary motivations of the theory of **automata** in all of its ramifications, especially in computation" (1979, p.181).

As to the **operation** of the **brain** W.J. FREEMAN (1975), (as quoted by S. GOONATILAKE, 1991, p.20) showed that "collectivities of nerve cells up to the **level** of ten million nerves ... have been studied as **dissipative structures** and shown to be **self-organizing** with **autopoietic** properties".

Presently, the analogy between neural networks (biological) and massively **parallel computers** (constructed **artifacts** assimilated to neural networks from a functional viewpoint) works in both directions.

S. STROGATZ and I. STEWART make the following and suggestive comment: "Neurons often act as **oscillators** and so, if central **pattern generators** exist, it is reasonable to expect their **dynamics** to resemble those of an **oscillator network**" (1993, p.73).

COLLINS, in turn, states: "...the concept takes its inspiration from the interconnected neurons of the **brain**. A neural network is "trained" by being given a series of examples of correct **responses** and the **connections** between its **processors** are strengthened or weakened according to its success of reproducing what is wanted".

... and "The neural network is never given an explicit body of **rules** to follow" (1992, p.40).

In other words, a neural network, is **trainable**. It does not receive an **algorithmic program** and its **behavior** is not precisely specified, nor standardised. It "learns", i.e. acquires **patterns of activities**, by progressive **adjustment** of **connections** between **inputs** and **outputs** through **feedbacks** and "**synaptic weighing**". It must not however present a completely **random behavior** if it is to reach some operative **state**: no *rigidly deterministic body of rules* does in effect mean no **rules** at all, since networks generally become functional through **Boolean switching functions** of either the type AND or the type OR.

D. GREENWOOD enumerates the following advantages in **information processing** by neural networks:

"1) **Information** learned by a network (i.e., stored in network **memory**) can be, as in biological systems, very tolerant to hardware failure and can be insensitive to arithmetic rounding problems...

"2) Existing network **learning methods** can circumvent the ordinary difficult problem of **programming parallel processors**. Networks learn by example and computer **algorithms** often are not required.

"3) **Pattern recognition** can occur in **parallel** and **patterns** with missing or distorted **components** can be completed.

"4) Feature extraction or **abstraction** can result as a by-product of the network **learning process** or from specially configured "competitive" networks.

"5) Neural networks can perceive and recognize spatial and/or temporal **patterns** in the presence of **noise** and with distortion. They also can process **discrete** or **continuous data**.

"6) **Hierarchies** of **data structures** can be represented as **layers** in a multilayer network.

"7) Conflicting aspects of **information** can be accommodated through network **self-organization**. Competing hypotheses can be represented, evaluated and selected in one network.

"8) Neural network classifiers can be non-**parametric** and make relatively weak assumptions concerning the shapes of underlying probability **density functions** compared to traditional statistical classifiers. Networks can learn multidimensional probability **density functions**.

"9) Networks can act as **controllers** in **environments** with several **constraints**" (1991, p.3).

Most of the former objections to **perceptrons** by M. MINSKY and S. PAPERT have thus been overcome.

However, D GERNERT observed recently that: "... the neural network still associate an **output pattern** to any given **input pattern**, such as the neural network itself can be considered a **model** of the original system. In a lot of practical applications this idea works with sufficient precision" (1994, p.128). But: "As far as can be seen presently, implicit **models** in neural networks do not open a way toward explicit **understanding**. A network can be prepared such as all internal weights and connection strengths at a certain instant can be measured, but such **data** offer no chance of an interpretation - no **rules**, **correlations**, or similar elements of our customary explicit **models** can be derived.

"Even worse, implicit **models** remain valid only as long as the conditions of their formation persist... Unfortunately... very often, the **decay** of such **models** creeps up slowly and unnoticed" (p.129).

It also seems probable that neural networks are submitted globally to **power laws**.

Neural networks are now much more that a kind of **metaphor** or abstract **model**.

D. FLOREANO writes: "by neural networks, it must of course be understood "nets of artificial neurons". These can be materialised either as electronic **components**, or computer simulated"(2002, p. 24)

FLOREANO and his team at the Federal Polytechnic School in Lausanne, Switzerland, have in fact created a real mobile mini-robot (**Khepera**) equipped with two wheels, eight luminous devices observing its **environment** and contacts conceived for spontaneous **connection** with electrical sockets when the robot is in need of **energy**.

Khepera's incorporated neural network is made of electronic components that may become interconnected in different ways, receiving any emitting **signals**, and transmitting them in a way similar to the **behavior** of biological neurons (2002, p. 24-26)

→ **Automata nets, von NEUMANN's architecture**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2279

NEURAL REPRESENTATION MODEL¹⁾⁽²⁾⁽⁵⁾

A device - formerly known as Wisard, and later Magnus - constructed by Prof. I. ALEKSANDER of Imperial College, London.

It was originally a "neural **pattern recognition machine**, an intelligent machine without a mind, just a layer of **neurons** which took a pattern in and labelled it".

Professor ALEKSANDER 's final goal is to modelize and study **consciousness**, as he goes on improving his **machine**. (2000, p.42-45).

This work is clearly related to so-called "**Artificial life**".

2280

NEUROCYBERNETIC PERSPECTIVE^{3) - 4)}

"A **metaphor** that emphasises active **learning** and **control** rather than the passive **adaptation** that characterises the "**open system**" view (R.L. FLOOD and M.C. JACKSON, 1991, p.10).

These authors stresses the interest of this view for **management** and **organisation** theory. They compare the positive and negative aspects of the same:

"Useful

"- It promotes self-inquiry and self-criticism and therefore the possibility of dynamic **goal-seeking** based on **learning**

"- When there is a high degree of **uncertainty** it encourages **creativity**

"When and why does it break down in practice:

"- It tends to forget that the **purposes** of the **parts** may not always be the same as the **purposes** of the **whole**

"- Adopting recommendations based on this **metaphor** would require most extant **organisations** to undergo significant **changes** that would threaten those that are favoured by the status quo; so they will be resisted

"- It neglects to recognise that **organisations** are socially constructed **phenomena**" (p.11)

As to this last point, it seems however that the neurocybernetic **model** could also help to reach a better **understanding** of social **constructs**.

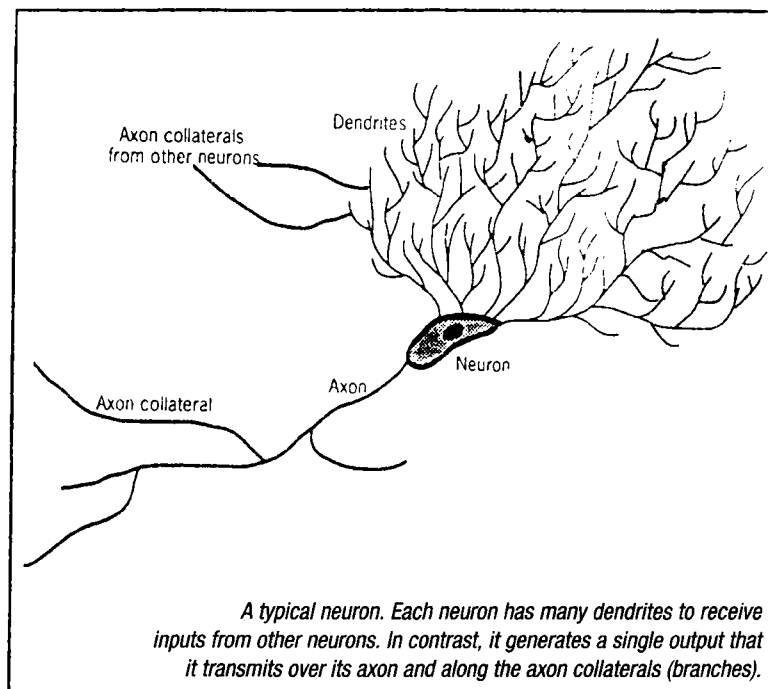
2281

NEURODE²⁾⁽⁵⁾

A local processing **node** in an artificial **network**.

Neurodes have been inspired by **neurons** in biological (**neuronal**) **networks**. Accordingly, they have many incoming **connections** from other neurodes in the **network**, but emit only one outgoing **signal**, as the product of a single computing operation. The neurode thus executes a **transfer function**.

Figure: see entry **Neuron**



From: CAUDILL, Maureen: "In our Image" - Oxford Univ. Press, New York, Oxford, 1992

2282

NEUROMIME^{2) - 3) - 5)}

A "synthetic system which can generate and propagate an **action potential**, and hence exhibit excitability" (R. ROSEN, 1979, p.181).

ROSEN comments: "... the relation between such **model** systems and their biological prototypes cannot reside in any identity at the particular **level**, but must reside in common functional or relational properties which are preserved **invariant** when we replace the prototype by the **model**. Thus the wide employment of **model** systems already reveals the tacit recognition of analytic alternatives to **reductionism**" (Ibid).

2283

NEUROMORPHIC ENGINEERING⁵⁾

A new technology aiming at creating chips modelled in accordance with **brain structures** (Economist, sept.22, 2001, p. 24)

Neuromorphic engineers construct devices that contain **elements** functionally equivalent to **neurons**, axons and even "a primitive rendition of brain chemistry" (p. 24)

These devices are **analog machines**, not digital ones, and their **output** is a **behavior**, not a logical calculus.

The Economist's reviewer writes: "What neuromorphic engineering seeks to do is to build tools that think for themselves- making **decisions** the way humans do"

Besides this somewhat anthropomorphic way to express the idea, the reviewer adds: "...the neuromorphic approach may be the only way of achieving the (elusive) goal to build efficient "**adaptive intelligent control systems**..."

It would rather seem that this technique is leading to active and **autonomous self-organizing** electronic systems

The subject is closely related to so-called **artificial life**.

→ **Parallel Distributed Processing**

FIG

2284

NEURON¹⁾⁽⁵⁾

A cell of nerve tissue whose parts are a nucleus, afferent **receptors** and an efferent axon.

Neurons communicate with each others through intervals called **synapses** (where complex biochemical exchanges take place), and within very intricate **networks**, particularly in the **neocortex**, the most organized part of the human **brain**.

C. KOCH and G. LAURENT state: "Exquisite molecular machines endow neurons with complex **nonlinear dynamical** properties, regardless of the animal's size or evolutionary lineage. Moreover, these properties are not static, but adaptively tunable" (1999, p.97).

see figure above

→ **Brain; Brain circuit; Brain metaphor**

2285

NEURON (Formal)²⁾

Model of the biological neuron made up by a binary **element** whose state is +1 (active) or -1 (inactive). (L. PERSONNAZ et al., 1988, p.1364).

These authors explain: "It was conceived by W. McCULLOCH and W. PITTS, from Chicago University in 1943... It updates its **state** periodically in the following way: It computes the sum of its **inputs** (which are the **outputs** of the formal neurons to which it is connected). The value of every **input** being modulated by the corresponding synaptic **efficiency**, it takes a decision by comparing this sum with a **threshold** of its own. If the sum is superior to the **threshold**, the neuron adopt its active **state** (+1); in the opposite case, it remains in its inactive **state** (-1)" (Ibid).

The formal neuron is thus a totalizer of impulses, combined with a simple **binary decider**, or an "**all or nothing**" model, as stated by H.von FOERSTER (1981, p.33).

(For more precise and detailed description and comments of this important **model**, see H.von FOERSTER, 1981, p.33-42)

→ **Parallel Distributed Processing**

2286

NEXUS²⁾

The link or links existing between the **elements** of a **network**.

Also sometimes referred to as "plex" or "plexus".

Generally, **systemics** and **cybernetics** study nexus (plural). The term "nexialism", for the study of complex, unexpected and supposedly unmanageable situations, was even proposed in 1952 by A.VAN VOGT in his science fiction novel "The Voyage of Space Beagle" (thus introducing this compiler first to KORZYBSKI's **General Semantics** and later on, to the Society for General Systems Research!)

2287

NICHE^{1) - 2)}

"That **part** of the actual **environment** relevant to the unit's **survival** (i.e. its continued **organizational closure** without **desintegration**) (R. HARNDEN, 1990, p.299). He writes: "... niche has to be separated out from **environment** in the same **process** that structured **mechanisms** relevant to **survival** become visible in terms of the **observer**... The first step in handling any **complexity** is to reduce the general **noise** of the total **environment**. Indeed, that is precisely how perceptual and **cognitive processes** function (e.g. **Gestalt**)" (p.300).

In short, the niche is the specific sector in the general **environment** wherefrom the basic **determinisms** of the system do emerge. J.J. GIBSON distinguishes clearly "**habitat**", from "**niche**": "A niche refers more to *how* an animal lives than to *where* it lives. I suggest that a niche is a set of **affordances**" (1986, p.128).

In a more specific way and, somewhat surprisingly, giving to the term quite an active sense, the UNESCO - UNEP "Glossary of environmental education terms" defines the ecological niche as follows: "The role, status and position of a species in the **environment**, its **activities** and relationships to the biotic and abiotic **environment**" (1983, p.9).

S. MARTINEZ observes: "... what is important is the extent to which any *growth* niche is linked and in what ways to others by invasion, exchange, or incorporation, perhaps even a **random encounter**" (1993, p.401).

Niches are not static since its occupants - plants, animals and also human **populations**, trades, products, techniques or concepts - cross-fertilize, evolve and co-evolve.

Clearly, "**niche**" is more an ethological than an ecological concept, even if both are interdependent.

2288

NICHE (Empty)²⁾

A potentially useful, but unoccupied part in an **environment**.

In an ecological environment, such empty niches may appear after important **perturbations**, as for example a cyclone, a bush or forest fire, or on new alluvial islands in a delta.

In human **activities** many unoccupied or underoccupied parts of all continents were once empty niches, apt for colonization.

Technical innovations are also frequently creating new empty niches in economic activities. The whole sector of electronics and computation is an impressive example.

2289

NK MODEL²⁾

A formal model of "rugged **fitness landscapes**".

This model has been introduced by S. KAUFFMAN to represent the internal **constraints** of a **complex system**. "In this model, *N* refers to the number of **parts** of a system - genes in a genotype, amino acids in a protein, or otherwise. Each **part** marks a **fitness** contribution which depends upon that **part** and upon *K* other **parts** among the *N*. That is, *K* reflects how richly cross-coupled the system is... *K* measures the richness of epistatic **interactions** among the **components** of the system" (1993, p.40).

KAUFFMAN's development and uses of his model (in genetics) are quite technical, but the model seems to be potentially very general.

An interesting development about this type of model, related to evolutive **fitness landscapes** can be found in P. BAK's 1996 book "How Nature Works" (p.118-27).

These models are also known as NKC models, *C* being the number of **couplings** between some particular trait in various interacting species.

→ **Co-evolution; Red Queen Evolutive parable**

2290

NODAL ACTIVITY^{2) - 4)}

The specific **processes** that take place at some defined points within a **network**.

The concept has been proposed by the sociologist A. STINCHCOMBE (1968, Ch.VI). This author, considering commercial and economic activities, emphasizes the existence of critical "**connections spots**", where some specific **operations**, mostly related to transportation and communication, are done in a better and easier way.

Obviously, the need for efficiency in the displacement or any kind of commodities or **knowledge** within a system (existing or self-organizing) tends to favour nodal activity. The nodal activity model appears in the works on **hexagonal space filling** of W. CHRISTALLER (1933; 1937) and A. LÖSCH (1944; 1954).

It also permeates the works of the French historian F. BRAUDEL (1982), who shows the successive **nodes** of commercial and financial **activity** in Western Europe from the 16th to the 18th century: Venice, Antwerp, Rotterdam, London, etc.

The concept is clearly related to the **neural networks models**.

2291

NODE^{1) - 2)}

A connected spot or **element** in a **graph** or in a **network**.

Atoms in a complex molecule, words in a **language**, people in an **organization** and generally any **elements** more or less selectively **interconnected** with others, become nodes, i.e. add **positional values** to their proper nature.

H.M. PAYNTER thus explains the properties of the nodes: "Most generally they might be unlabeled and therefore uniform and undistinguishable. However, in any **directed graph**, some of the **branches** incident on a given node will be directed toward it, others away. But it will always be observed that for unlimited richness of **structure** all **graph** systems must have at least one (type of) node with three or more **branches**, and that if the **graph** is **directed**, at least two **branches** must be directed toward this node. Moreover, as the American philosopher and logician C. S. PEIRCE discovered

nearly a century ago, but one **triadic node**-type, with two **in-branches** and one **out-branch** is necessary for infinite **variety of structure**" (1968, p.76).

→ "Node (Triadic)"

This node **model** does now appear as absolutely fundamental for the understanding of **neural nets**, which in turn are basic **models** for any interpretation of **complex systems** formed by numerous interacting **elements** (each of which can be considered a node). On the other hand, PEIRCE'S **model**, which is the most elemental summation device, anticipated, for instance, the Mac CULLOCH-PITTS neural transmission **model**.

Complexity of **networks** grows factorially in relation to the number of their nodes and the **connexions** between these.

2292

NODE (Critical)^{1) - 2)}

A node whose suppression in a **network** impairs its functionality.

Impairment can be partial or complete, temporary or definitive. Generally, subtracting (or adding) a node in a **network** may implicitly affect the whole **network**, but not necessarily in a critical way. Three main possibilities exist:

- The **change** produces the **network's** destruction;
- A progressive **damping** absorbs the modification;
- the **change** triggers the **emergence** of a **network** on a higher level of **complexity**

Redundancy in the **network** may allow for its sufficient reorganization in case of partial destruction. Examples are the spontaneous reordering of the **brain** after a non-fatal cerebral haemorrhage, or of a military unit after a rout.

2293

NODE (Triadic)²⁾

A node "... with two **in-branches** and one **out-branch**" (H. PAYNTER, 1968, p.76).

The **concept** of triadic node was introduced by C. S. PEIRCE.

H. PAYNTER emphasizes: "At the level of **binary logic**, PEIRCE himself anticipated SCHEFFER in the discovery of the alternate denial and joint denial **operators** (the modern NOR and NAND)... A universal triad must be both associative/dissociative and symmetric with respect to **in-branches**" (p.77).

2294

NOISE¹⁾

A **random** non-rhythmic **disturbance** in a communication **channel**" (J.Z. YOUNG, 1978, p. 296)

"The perturbing **part** in a temporal **signal**" (R. VALLÉE, 1992).

or, with more detail: An environmental **disturbance** which reduces the **reliability** of the **message** transmitted through the **communication channel**.

VALLÉE's definition gives the general sense of the term, not merely the technical one.

The noise is the part of the **signal** which is not understood, or seems still senseless. VALLÉE states that the complete **signal** is the sum of its significant and non-significant **parts**.

About the concept of "**order from noise**", he writes: "Noise does not create **order**, but it is an excellent developer (in the photographic sense) of **structure**... It can also, through the **fluctuations** that it provokes, become a "**structure trigger**" (Ibid).

This is **nucleation** in conditions of **dissipative structuration**.

Other interesting comments about noise are:

"All that is not **information**, not **redundancy**, not **form** and not restraint – is noise, the only possible **source** of **new patterns**" (G. BATESON, 1973, p.386)

"... in my restaurant, **self-organizing systems** do not only feed upon **order**: they will also find noise on the menu" (H.von FOERSTER, 1981, p.15).

"It is not bad to have noise in the system. If a system freezes in a specific **state**, it cannot anymore adapt, while this final **state** may easily be faulty and it will not be able to adapt to anything that would be an inadequate **situation**" (H. ATLAN, 1972, p.24, quoting von FOERSTER, 1960, p. 31-50)

According to C. ZIMMER (1999, p. 86) "**non-linear dynamics** seems to amplify noise"

Apparently, the significance of noise is deeply modified in **deterministic chaos**.

It becomes either enhancing and constructive, or on the contrary destructive, in particular in relation to some peculiar conjunction of environmental conditions acting as **amplificator** or **constraints**.

2295

NOISE GENERATOR^{1) - 2)}

Any **source** which produces an unpredicted sequence of **events**.

D. MacKAY considers the case of the noise generator as **information** producer in these terms:

"a) A noise generator... is a **source** not primarily of **information** but, if we must call it a **source** of something, simply of surprise

"b) it becomes a **source** of **information** if and insofar as it leads to representational **activity**, and its "**output of information**" is to be measured relatively to the ensemble of **representations** on which it evokes selective **operations**

"c) a **source** does not, however, produce significant **information** unless the representational **activity** evoked has significance for some **receiver**" (1969, p.137).

Further on, Mac Kay states: "... a noise generator can be regarded as a **source** of completely original, but **meaningless information**" (p.137).

2296

NOISE in a channel⁵⁾

Any **random disturbance** originated in the **environment** which reduces the **reliability** of a **message transmission** in a **communication channel**.

SHANNON'S so-called 10th Theorem states: "If noise appears in a **message**, the amount of noise that can be removed by a correction channel is limited to the amount of **information** that can be carried by the channel

This is quite similar to ASHBY'S "**Law of Requisite Variety**"

Many practical examples are well known, for example in radio, T.V., telephone, fax, etc... **transmission**.

K. KRIPPENDORFF comments: "The **analogy** between noise and **thermodynamic entropy** is suggested by the fact that in any **communication process**, noise can only increase and it does so at the expense of the amount of **information** transmitted from a sender to one or more **receivers**" (1986, p.53).

In some cases, noise **disturbances** may endanger the functional **reliability** of **parts** or even the **whole** of a system: a lightning may put an electric circuit out of order, or a jumbled **message** may impair some critical **action**.

R.L. ACKOFF and F.E. EMERY distinguish **semantic**, **syntactic** and pragmatic noise. On this last they write: "Pragmatic noise (is) anything that appears in a **message** or its **environment** that was not produced by the sender and decreases the probability of the **receiver's** responding in the way intended by the sender" (1972, p.182).

T.F.H. ALLEN and T.B. STARR go further and define noise as "Any aspect of a **signal** string which is not considered significant" (1982, p.274)

Or: "That part of the **signal** which is not considered to be associated with **meaning** for the **purpose** at hand" (Ibid).

The word "considered" introduce (rightly) a doubt, as in this case, either the sender, or the **receiver** – or both – may well miss something significant in the **message** only because they do not *consider* it – or simply do not understand it – to be significant!

It must however be admitted that "significance" is a characteristic of the **observer**, which moreover, may subtly depend on her/his interpretative ability. BECQUEREL'S veiled photographic plates where spoiled by "noise", until he did understand the **correlation** with the (radioactive) samples that he had stored in the same drawer, without noticing their peculiar **behavior**.

2297

NOISE in a SYSTEM²⁾

A **perturbation** "which interferes with the otherwise **deterministic behavior** either additively, or through some of the **parameters** characterizing the system" (G. NICOLIS and I. PRIGOGINE, 1978, p.30).

Such a noise can generate an **oscillation** that can be **damped**, or lead to the destruction of the system, or play a critical role to orient **dissipative structuration** at a **bifurcation point**.

From this viewpoint, and according to G. BATESON, quoted by E. MORIN, anything which is neither **information**, nor **redundancy**, nor **form**, nor **constraint** is noise. (1972). However BATESON considers that noise is the only possible **source of new patterns**.

This view is expressed by H.von FOERSTER in this way: "Thus in my restaurant, **self-organizing** systems do not only feed upon **order**, they will also find noise on the menu" (1960, p.31). H. ATLAN puts it as follows: "It is not bad to have noise in the system. If a system freezes in a specific **state**, it becomes unadaptable and the final **state** may easily be faulty. It will not be able to adapt to anything that would be an inadequate **situation**" (1972, p.24).

While this is acceptable, let us remember that too much is too much! ...and that it may be difficult to know when a critical **threshold** of noise is too close for security.

Noise can also be generated within the system, which possesses internal **communication channels**. This is doubtless the case in biological and in **social systems**.

2298

NOISE (Sensibility to)¹⁾

As systems become more complex, their capacity to perceive become more differentiated, and they register more **signals** originated in their **environment**.

Some of these **signals** are immediately significant, because similar **signals** were previously incorporated to meaning **sets** already organized within the system.

Others are not and must be considered as noise. Complex systems, when registering noise in increasing quantity and diversity, can survive only by enhancing their capacity to create **complexity** in their internal **representations**, i.e. by assimilating these noises in a significant way. How this is done is not yet very clear. However this process seems indeed to be a very general trend in **evolution** and may even be the cause of what F. MEYER described as **evolutive acceleration** (1954)

→ "Order from noise"; "order parameter".

2299

NOMINAL GROUP TECHNIQUE

→ **Group Technique (Nominal)**

2300

NOMOGENESIS²⁾³⁾⁵⁾

"Directed increase of **complexity** (pre-adaptation) and immediate effect of the **environment**" (as defined by V.V. NALIMOV, 1985, p. 32)

Nalimov relates nomogenesis to **Bayesian probabilities**: "The Bayesian syllogism, in accordance with Nomogenesis, ignores the creative role of **natural selection**. However, what we keep in mind is not complete rejection of natural selection as a factor of **evolution**, but the abandonment of the concept of evolution as a **random search**" (Ibid)

It seems obvious that evolution, i.e. any kind of evolution, must necessarily be a compromise between **processes** and **structures** that self-constructed as results of **constraints** in the past (but still in force) and the possibility or need for innovation.

It would be interesting to compare these views with the concept of **deterministic chaos** and **self organization**.

→ **Artificial life; Co-evolution; Morphic field; Neoteny; Network behavior; Parallel distributed processing**

2301

NON-, NO-³⁾

The French philosopher G. BACHELARD, in his "Philosophie du non" (1949), was one of the very firsts to state clearly the progressive but unavoidable escape of most sciences from the limits of the aristotelic and mechanistic thinking. He emphasized the importance of **connections** and **complementarity** (as for example in HEISENBERG's **indeterminacy**) as leading to the need for "non-analyticity". He also discussed KORZYBSKI's non-aristotelician logic (1933) and O.L. REISER's "Non-aristotelician logic and the crisis in science" (1937). This led him to extol the synthetic value of no-, or non-positions in the sciences, meaning a general conceptual extension outside the boundaries of classical **reductionist** ones, but without excluding these latter.

We are now able to better understand his proposals, for an inductive and synthetic **epistemology**, after the discovery of non-newtonian **dynamics**, **non-equilibrium** chemistry, **non-homeostatic** systems, **nonlinear** and **non-deterministic** macrosystems (i.e. **chaotic determinism**) (all of these already preceded by non-euclidian geometries during the 19th century!).

→ **Non-Principles**

2302

NON - PRINCIPLES^{2) - 3)}

The French biologist H. PRAT made a census of a number of negative principles which contributed or could contribute to open new horizons to 20th (and 21st) Century sciences:

"1. Principle of non-identity: In experimental sciences, identity does not exist (two **objects** or **elements** can never be identical). ... A mitosis, for example, is never strictly equational. Ignoring this fact led to many persistent errors in the interpretation of animal and vegetal organogenesis".

"2. Principle of non-repetition: As the **set** of causes corresponding to an experience A can never be identically reproduced in an experience B, only a more or less great probability can exist for **confirmation** in B of the results obtained in A; but never an absolute certainty. The probability increases with the number of concurring experiences, but never becomes infinite".

"3. Principle of non-extrapolation: All laws and concepts that we formulate are only valid within given **limits**: those accessible to our **observations on space, time energy, information scales**. Beyond these **limits** we should not extrapolate".

"4. Principle of non-independence: All **elements** and **parameters** in the universe are interdependent. Any modification of one, modifies in some measure (big or small) all the others".

"5. Principle of non-constancy: In the universe, nothing is absolute: there are no universal constants; nothing is totally **invariant**".

(This revolutionary statement leads its author to emphasize a totally abstracted formulation of $E = mc^2$, that should make it practically disembodied... and useless).

"6. Principle of non-limitation: No **limit** may be imposed to any **magnitude** in the universe, which is limitless in all the hyper-space scales: **space, time, matter, energy and information**" (1968, p.3-4).

While these ideas should be taken "cum grano salis", as "food for thought", it should be noted that other non-principles were formulated by HEISENBERG and EINSTEIN, as well as by the **non-aristotelician** Polish-American logician A. KORZYBSKI, the Austrian mathematician K. GÖDEL and the French philosopher G. BACHELARD... not forgetting PRIGOGINE's **non-equilibrium thermodynamics**. They are undoubtedly present in systemics, where "the **whole** is *not* merely the sum of the **parts**" and in cybernetics, where **causality** is *not* anymore **lineal**.

Somehow, non-principles are related to **complexity**, as we finally met it in our minds.

→ **NO-, NON**

2303

NON-ARISTOTELICIAN THINKING^{3) - 4)}

A. KORZYBSKI, who introduced what he called non-aristotelician thinking wrote: "The... non-aristotelician system is based on fundamental **negative** premises; namely, the complete denial of "identity", which denial *cannot be denied* without imposing the burden of impossible

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

proof on the person who denies the denial. If we start, for instance, with a statement that 'a word is *not* the **object** spoken about', and someone tries to deny that, he would have to produce an actual physical **object** which would *be the word*... This general denial of the 'is' identity gives the main fundamental non-aristotelician premise... The status of negative premises is much more important and secure to start with than that of the positive 'is' of identity, found in the aristotelician system, but easily shown to be false, and involving important delusional factors.

"Any **map** or **language**, to be of maximum usefulness, should, in **structure** be similar to the **structure** of the empirical world. Likewise, from the point of view of a theory of sanity, any system of **language** should, in **structure**, be similar to the **structure** of our nervous system. It is easily shown that the aristotelician system differs structurally from these minimal requirements, and that the non-aristotelician system is in accordance with them.

"This fact turns out to be of psychophysiological importance." (1950, p. 10-11).

KORZYBSKI insistently recommends training in non-identification as a way to protect psychological and mental sanity and gives numerous practical ways to do it. He views abusive identification as the root of most psychological and socio-political problems.

→ See also: **map-territory relation; non-identity principle; self-reference; structural differential; time-binding.**

Autopoiesis and **organizational closure** are obviously non-aristotelician concepts. So are most modern scientific theories related to **complex systems**. (See "**Non – no**").

KORZYBSKI's fundamental work on non-aristotelician concepts is undoubtedly a corner stone for **general systemics**.

2304

NONEQUILIBRIUM¹⁾ – 2)

The condition of a system undergoing ever wider **fluctuations** until it reaches some critical **unstability threshold**.

The basic understanding of nonequilibrium evolved considerably in the recent years. Before, as stated by I. PRIGOGINE et al, it was "considered as a **perturbation** temporarily preventing the appearance of **structure** identified with the **order at equilibrium**" (1975, p.17).

However, as stated by I. PRIGOGINE "nonequilibrium may be a source of **order**" in its own right, through the mechanism of **dissipative structuration**" (1978, p.1/2).

Widely fluctuating systems, writes E. JANTSCH: "... try to maintain their capability for **energy** exchange with the **environment** by switching to a new dynamic **regime**" (1976, p.38).

This occurs through **dissipative structuration** and may lead to higher **organization**, in accordance with the principle of **order through fluctuation** established by I. PRIGOGINE. This higher internal **organization** of the system implies inevitably a higher **level of entropy** production.

N. ZELENY and N. PIERRE state: "Both nonequilibrium and **instability** are essential for **self-organization** of higher **complexity**" ...and by the way "Human systems **management** is **not** optimal **control** theory or theory of **conflict** resolution" (1976, p.164).

In the same vein, A. TAYLOR writes: "Nonequilibrium systems are characterized by a high degree of **energy** exchange with the **environment** (and can therefore be termed **dissipative structures**). Thus, nonequilibrium **dynamics** is moving toward a theory of **self-organization** of **processes** and **structures**, applicable not only to the physical but to the biological and social **domains** as well" (1976, p.176).

2305

NON-ERGODICITY¹⁾ – 2) – 4)

The characteristic of a non-strictly **deterministic** system which offers only **long-term** non-repetitive **behavior** to the **observer**.

According to K. KRIPPENDORFF this **situation** involves only "**transient states** which are unique,... or **transition** probabilities (that) are so variable that there are not enough **observations** available to ascertain them" (1986, p.53). While both types of **situations** are very different, they are practically undistinguishable in most cases.

And: "**Evolution** and **social processes** are inherently non-ergodic. To understand non-ergodic **behavior** requires either reference to the underlying **organization** of the system exhibiting it or the study of a large sample of systems of the same kind" (p.53).

The precise **limits of ergodicity** have been better defined by the use of LYAPOUNOV's **exponents** (in theoretical **modeling** at least). Moreover, the perspective on non-ergodicity is now modified by **chaos theory** and its reference to the oblivion of **initial states**, as well as by **dissipative structuration**.

As to **social systems**, their "**underlying organization**" is still quite enigmatic, even in terms of **networks**. It is also practically impossible to study "large samples of systems of the same kind". Non-ergodicity remains a great challenge for systemics.

2306

NON-IDENTITY PRINCIPLE²⁾ – 3) – 4)

This principle was quite graphically expressed by A. KORZYBSKI, when he stated that "The map is not the territory" (i.e.: the **label** is not the **object**, and **label** on **level 2** of **abstraction** is not to be confused with **label** on **level 1** nor

with **label** on **level 3**). The Belgian surrealist painter R. MAGRITTE who painted a pipe with the caption: "This is not a pipe", made the same point.

The non-identity principle is the only way out of the paradoxes provoked by **self-reference**, whose pernicious effects were described by A.N. WHITEHEAD and B. RUSSELL in their "Principia Mathematica" and further considered by H.von FOERSTER, who in turn inspired H. MATURANA in his work on **autopoiesis** and F. VARELA in his **calculus for self-reference**.

The non-identity principle leads also to a **recursivity** of expanding logical **layers**, as a result of GÖDEL's **incompleteness theorem** and is related to D. BOHM's concept of **generating order** (1987).

On psychological ground non-identity leads to non-identification, i.e. to avoid the identification fallacy, which, as shown by KORZYBSKI, opens the road toward mental illness.

2307

NON-INTEGRABILITY²⁾

Condition of a system "...characterized by a continuous spectrum and the presence of continuous **sets of resonances**" (I. PRIGOGINE et al, 1991, p.3).

Such systems are complex, having a number of interconnected **internal** conditions. In the authors words: "As is well known, non-integrability leads to the appearance of **random trajectories** and **chaos**" (Ibid).

This feature led recently the authors (in the referenced paper) to introduce an **internal time** in their classical and quantum mechanics **models** "... describing the **relations** (the "**correlations**") between the particles (Ibid).

The **internal time** – in a biological **context**, and based on empirical observations – was described in the thirties by the French biologist P. LECOMTE du NOÛY (1936).

2308

NONLINEAR²⁾

Character of a system whose **parameters** do not vary in arithmetic proportion.

This nonlinear character is generally ignored in many **models** because assumed **linearity** enormously simplifies **modeling** and produces simple solutions.

J.W. FORRESTER observed: "There has been a reluctance to give up the **linear** mathematical procedures, with the result that **models** have been biased to fit the **linear** procedures at the expense of faithfulness in representing the real world" ... and "Accepting nonlinearity tends to force a person out of the world of theorist into the world of the practitioner" (1973, p.104).

In effect, **linear** approximations become unreliable near nonlinear **thresholds**.

In A. McROBIE and M. THOMPSON words: "If we include the nonlinearities of the system in the analysis, then more than one **steady-state** solution is produced and the one on which the system settles will depend on its **initial conditions**" (1990, p.42).

2309

NONLINEAR DYNAMICS

→ **Dynamics (Chaotic); Dynamics (non linear)**

2310

NONLINEAR PARADIGM³⁾

L. DOUGLAS KIEL proposes to label in this way a **methodological** framework which already includes a **variety** of theories as for instance nonlinear **dynamics** and **chaos theory**. (1992, p.28).

He could add **self-organization in nonequilibrium systems** (PRIGOGINE et al); **networks** theory (RUMELHART and Mc CLELLAND); **catastrophes** theory (THOM and ZEEMAN); **synergetics** (HAKEN); **Hypercycles** theory (EIGEN); **fractals** (MANDELBROT) and possibly some more.

2311

NONLINEARITY^{1) - 2)}

Characteristic of a relation in which the **variable** is multiplied or divided by coefficients themselves **variable**.

"What comes out of a nonlinear equation isn't proportional to what goes in; unlike linear equations, they may contain **feedbacks** and **thresholds** and other features that can yield complicated results"(C. ZIMMER, 2000, p.84)

Some examples are: exponential, or **logistic**, or asymptotic **growth**, **cyclical variations** and **chaotic behavior**.

According to F. BAILLY, F. GAILL and R. MOSSERS, "Nonlinearity corresponds to the growing **complexification process** associated with **iteration**, as in **morphogenetic complexification**. A mere linear **iteration** would be purely additive and unable to account for a progressive, **structural** and **functional complexification**." (1991, p.58).

Any **iteration**, in order to lead to **complexity**, must go with the creation of specific **links**, i.e. restricted ones in relation to all the potentially possible ones, but still not merely additive.

L. DOUGLAS KIEL observes: "(their) **sensitivity to initial conditions** means that nonlinear systems are **historical systems**. Furthermore, nonlinear systems are a result of both **determinism** and **chance**. While the **history** of the system determines its **evolution**, the **element of chance**, ranging from the nature of external shocks to changing internal **dynamics**, plays an essential role in the **evolution** of the system" (1992, p.34).

This formulation seems somewhat ambiguous.

It should be clearer to say that, in the history of any system, pure **determinism** is perceived as having reigned until the present moment, because the system reached its present **state** through one and only one line of **transformations**, while more or less **chaotic determinism** becomes dominant into its future.

Moreover, while the term "**evolution**" is very frequently applied to the adaptive transformations of systems, this use is questionable: *Individual* systems do not undergo **evolution**, but merely some occasional **mutation**, which becomes immediately fixed (*if* not lethal and *if* transmitted).

2312

NON-LOCALITY^{2) - 3)}

The boundless influence of an **element**, **event** or system in **space** and **time**.

The status of the concept – generalized by D. BOHM – is still somewhat obscure and controversial.

In BOHM's words, there is an "implicate **order**... This order is not to be understood solely in terms of a regular arrangement of *objects* (e.g., in rows) or as a regular arrangement of *events* (e.g., in a series). Rather, a *total order* is contained, in some *implicit* sense, in each region of **space** and **time**" (1980, p.149).

BOHM exemplifies this as follows: "Thus, in a television broadcast, the visual image is translated into a **time order**, which is 'carried' by the radio wave. Points that are near each other in the visual image are not necessarily near in the **order** of the radio **signal**. Thus the radio wave carries the visual image in an *implicate order*. The function of the **receiver** is then to *explicate* this **order**, i.e. to 'unfold' it in the form of a new visual image" (Ibid).

An **hologram** offers another insight in non-locality, as its **whole information** content is scattered in its **whole** extension.

I PRIGOGINE observes that some **transformations** are non-local as they replace "a point by an ensemble" and "break the temporal **symmetry**" (1986, p.10). This is an interesting clue.

The non-locality concept is somehow endorsed by H. SABELL: "In the language of **Process theory**, only the material **component** of a system is local, whereas the **energetic** and **informational** aspects irradiate boundlessly" (1992 b, p.682). It is debatable if this is exactly BOHM's idea.

If finally well confirmed, non-locality will very probably become a cornerstone for a cosmic generalization of **systemics**.

In the recent years, research on non-locality and the related **phenomena** of **entanglement** and decoherence in quantum mechanics has entered in its experimental phase.

However, particles behavior and the macroscopic world of classical mechanics remain still at odds for our common **understanding**.

As stated by S. HAROCHE in a paper explaining research in course: "The results of all these experiments are counter-intuitive"(1998, p. 36-42)

→ **Quantal representation; Quantum hologram; Quantum vacuum**

2313

NONSPECIFICITY^{2) - 3)}

A type of **uncertainty** brought about by the existence of a set of alternatives.

G. KLIR states: "Nonspecificity is exemplified by the HARTLEY measure in classical **set** theory: the greater the **set** of alternatives that are left undecided in a **situation** (e.g. **predictions** or prescriptions), the less specific the **situation** is; when only one alternative is possible, the **situation** is fully specified" (1991, p.118).

Nonspecificity can easily remain unrecognized in complex **situations**, leading to **under-conceptualization** (WARFIELD) and serious mistakes in diagnosis, **forecasts**, **design** and **planning**.

2314

NOOSPHERE^{1) - 4)}

"The sphere of **interrelations** between society and nature within the **limits** of which the wise human **activities** become the main factor of **development**" (UNE.1, p.19).

The definition from the "Glossary of environmental education terms" of UNESCO – UNEP seems optimistic.

While the existence of the noosphere is evermore evident and human intervention upon nature evermore intense, it is far from evident that it is always "wise" and that it leads finally to a **development** which is supposed to be **sustainable**.

A harmonious noosphere would need quite a better **understanding** by man of the **effects** of his interferences with natural **processes** now and in the future (specially at **long term**).

The word and concept was introduced by the well-known French Jesuit and paleontologist P. THEILARD de CHARDIN around 1950.

2315

NORM³⁾

1. A behavioral standard or **model** applicable to a specific **class** of systems.

Norms systems are practical **codes** for any type of transactions at a wide social **level**.

Norms translate **values** to the **level** of enacted **behavior**. They settle down as a **consensus** through repeated interactive **feedbacks** between users, because they permit a great economy of **resources** by avoiding uncertainties, incompatibilities, **conflicts**, and un-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

necessary iterative experiences and **complexity**. They also increase the systems **predictability** and make it more easy, i.e. less costly, to maintain.

Hierarchies of norms may appear, as encompassing global norms are produced through the **interactions** of local and specific **needs** of systems entering a more global one. (e.g. European norms superseding national ones).

Norms may however need to evolve as for example technical ones. This is generally a difficult **process**, because they precisely are designed to enhance **stability**. As a result, there is a general tendency to cling to established norms and to resist new ones.

2. The most common **behavior** of a system, as defined by "normal" **distribution**.

This is a mathematical concept, which is in no way connected with the former one.

2316

NORMATIVE ETHICS

→ **Ethics (Normative)**

2317

"NOTHING BUT " FALLACY ¹⁾²⁾³⁾

The kind of superficial **analogy** that blocks the mind in a restricted and excluding **schema** about some **entity** or **issue**.

This fallacy was strongly denounced by K.L.von BERTALANFFY. An example is: "An **organism** is nothing but a **machine**". Vague analogies should be replaced by the **perception** and clear **understanding** of specific and limited **similarities**.

Even the term "**isomorphism**", proposed by Bertalanffy himself, should be used carefully. In fact any "isomorphic" model of an entity is no more than **homomorphic**. It represents merely some selected and seemingly significant aspects of the entity.

Only models of two or more different entities could be isomorphic models. A good example are the isomorphisms between levels in MILLER's **taxonomy of living systems**.

To avoid mere analogical fallacies, Bertalanffy resorted to mathematical expressions as far as possible. M. DAVIDSON, (quoted by M. MULEJ) wrote: "By using differential calculus, he was able to provide mathematical precision to such GST concepts as **dynamic equilibrium** (the **steady state**), the import of **energy** from the **environment** (**negentropy**), and self-restoration in response to external **disturbances** (**equifinality**)"

Topology is now also a source of precise **modelling** for isomorphisms in **processes**. Examples are **attractors** or **Poincaré sections**. Other useful precise models are **networks**, **power laws**, **renormalization transformations**.

Graphs and **matrixes** are also useful.

2318

NUCLEATION MECHANISM ^{1) - 2)}

A mechanism by which a new **structure** establishes itself first in a limited **region** and than invades the whole **space**.

According to G. NICOLIS and I. PRIGOGINE, the concept originates in physico-chemistry as "... the **phenomenon** of *nucleation* familiar from **equilibrium phase transitions**" (1977, p.323).

It appears when a system submitted to widening **fluctuations** becomes **unstable**, which leads to **dissipative structuration**. The new **structure** will be a more or less randomly result of the antagonism between the **instability** that tends to amplify the **fluctuation** and "the effect of the large outside **environment** in which **fluctuations** may be neglected. The outside world thus acts as a mean **field** that tends to **damp** the **fluctuations** through the **interactions** which occur on the **boundaries** of the **fluctuating region**... In the case of small size **fluctuations**, **boundary effects** will dominate and **fluctuations** will regress. On the contrary, for large scale **fluctuations**, **boundary effects** become negligible.

Between these limiting cases lies the actual **size** of nucleation. This is the reason why a general law of **fluctuations** independent of size, such as given by a **POISSON distribution**, is no longer valid" (PRIGOGINE et al., 1978, p.52).

The same mechanism is obviously present in **population genetics** and in technical innovation, for instance. P.P. GRASSÉ's **stigmergy** also is an example of a nucleation mechanism.

2319

NUCLEATION PRINCIPLE ^{2) - 4)}

"Any **structure** has a minimum **size**, which is its "**nucleus**" (K. BOULDING, 1956, p.70)...and "which results of a "mysterious initial act of nucleation" (p.71).

BOULDING states that the term comes originally from physics, but has a quite wider sense. He writes: "Once a **nucleus** has been formed, it is not too difficult to understand how **additions** to the **structure** are made. The formation of the **nucleus** itself, however, presents many problems which are quite different from those involved in the **growth** of an already established **structure**".

He gives the example of the crystal, whose minimal **nucleus** is, by necessity, an ordering of atoms which, as individuals are not crystals and cannot be a **nucleus**. He adds: "In the case of the **cell** the problem of nucleation is almost completely unsolved" (ibid).

On this matter, some important progress has been made since 1956. See: "**Autogenetic system precursor**"; "**Morphogenesis**".

BOULDING also points out that the same **phenomenon** appears under the guise of social innovators "those mysterious individuals who establish religions, cultures, nations, techniques and ideas" (ibid).

→ **Zero system**

2320

NUCLEUS (Original) ^{1) - 2)}

The minimal initial **structure** from and around which the system will construct itself by **replication** and, in many cases, by **differentiation**.

This concept was introduced by BOULDING in 1953, but until V. CSANYI's work (1989, 1993), it had never been duly scrutinized, at least in its systemic sense. The original nucleus seems to contain a kind of basic **algorithm** needed to guarantee the **autopoietic** future of the system, i.e. its permanent identity and **coherence**.

However, the potential of this **algorithm** does reveal itself by progressive **differentiation** and structuration through **interactions** of the system with its significant **environment** (which becomes also defined by the original nucleus).

In very **complex systems**, the potential of the **algorithm** is so enormous that it can never be completely expressed during the **life-time** of the system, which must make "**choices**" frequently and generally cannot retrocede to anterior forms of **organization**. These **choices** imply a progressive limitation of the virtual possibilities of the system. Such comments apply to individual personalities, **organizations** and cultures.

BOULDING also observes that the nucleus is generally some **heterogeneous element** or "impurity", wherever it appears. This seminal comment, in turn and unfortunately did never arouse much attention.

2321

NUMBER (Random)

→ **Random Number**

2322

NUMBERS (Law of Great) ²⁾

H. SIMON has stressed the importance of the Law of Great numbers as an **aggregation** tool, or **variety reductor**. He gives statistical mechanics as an example of this simplifying potential. By its use "it transforms the enormous **complexity** of a mechanical microsystem into the relative simplicity of **macroscopic thermodynamic** regularities.

"Through **stochastic processes**, we simplify the **description** of a **dynamic system's history** by ignoring temporal **trajectories** of its various **elements** and by considering solely their **distribution** among the **states** of the system and the **transference** probabilities from one **state** to another. Another important simplification is obtained by considering only the

equilibrium states of such systems, which can be frequently calculated without taking in account the **trajectories** used to reach these **states**" (1990, p.140).

2323

NUMBERS (Prime) ^{1) - 2)}

As **incommensurability** in conjugated **periodic processes** in a system seems to be a condition for **chaotic behavior** (P. BERGÉ and M. DUBOIS, 1992, p.120), it also seems that the **interrelations** between prime numbers are a basic subagent factor of **complex systems organization**.

Non-ergodic behavior in **complex systems** with a superposition of **processes** of different **periodicity** could be related to prime numbers.

If the various **periodicities** are defined by different prime numbers, their interferences produce an apparently **random behavior** for very long time before any possible repetition of the original **sequence**. Such repetition would be determined by the minimal product of the different **periods**. Thus the basic global **determinism** will remain hidden and very difficult to discover when a very long **observation period** is not yet available.

0

2324

OBJECT ^{1) - 2) - 3)}

1) A physical and observable entity endowed (by the **observer**!) with specifiable **morphological** and **functional** properties.

2) "A **set** of forces, with finite values, coordinated by a **regulation** system, in such a way as to produce stable and **observable** qualities, when left to itself in its natural surroundings" (C.P. BRUTER, 1973, p.33).

According to J.J. GIBSON we distinguish between objects as they lend us, or not some specific capabilities of **action (affordances)** (1986, p.133).

H.von FOERSTER sustains that "objects are representations of **relations**", an opinion that he even extends to "**events**" (1982, p.265).

Thus, the notion of object hovers at the confines of reality and **subjectivity** (individual or collective).

According to the given definitions, the object is not very different from the system (in its most general sense).

J.L.LE MOIGNE resumes as follows some of C.P. BRUTER's comments: "Within the **fields** of forces that occupy the **environment** (surroundings), the instantaneous **equilibrium** of these forces which create the observable object re-

sults from and is maintained by the object itself, which escapes somehow from its "parents" and develops its own identifiable project of existence" (1990a, p.151).

This concept is very close to LAVILLE's (1950), who however expresses it in a less tautological manner. LAVILLE shows moreover how "antagonistic **fields** of forces" give rise to the **forms** of the "objects".

This is also perceived by G. KLIR who states: "... the object, which is the subject of our interest, is never completely isolated from its **environment**" (1965, p.31).

J.von UEXKÜLL gave this lapidary definition, which confirms however that any object is an **observed** one: "An object is what moves together" (Quoted by K. LORENZ, 1962, p.47). We should maybe correct this statement as follows: "An object is what we perceive as moving together". In A.L. GOUDSMIT words it is the result of: "multiple **recursive** coordinated **actions**. We will, thus, regard objects as **elements** of **consensual domains** in that they consist of intricately stabilized **patterns of interrelations**" (1989, p.175).

G.P. SHCHEDROVITZKY distinguishes however between the "object and the "thing known", in these terms: "The object exists independently of **knowledge**. The thing known, on the contrary, is formulated by **knowledge** itself" (1966, p.32). There is a danger of semantic confusion: We should better consider the "object" as the result of our **observation** of "that thing there outside" (As proposed by A. KORZYBSKI - 1933 - 1950).

In the art photographer W. BULLOCK words (quoted by E. JANTSCH, 1975, p.90): "An object is actually a visual or mental **concept**. It has no independent physical existence. Only **events** exist". This view is very close to KORZYBSKI's ones.

H.von FOERSTER made the same point in his paper "Objects: **Tokens** for Eigen behaviors" (1976)

→ "**Organization, (the nine levels of)** (of **objects or systems**).

2325

OBJECTIFICATION ¹⁾²⁾³⁾

J.van GIGCH writes: "In EINSTEIN's science, "objectification" consists of inventing mathematical equations whose "**objects**" are mathematical **entities**. The senses and **perception** do not intervene in any way, except to the extent that observational **data** become "objects" of theoretical statements" (2002, p. 202)

van Gigch comments: "The extend to which these objects are conceived independently of perception or of empirical data is somewhat debatable" (ibid)

According to von FOERSTER such independence is a delusion. Einstein himself "conceives a threefold distinction between:

a) the external world

b) the **observer's** perception of that external world; and

c) our notions of it" (ibid)

Accordingly, EINSTEIN wrote: "As far as the laws of **mathematics** refer to **reality**, they are not certain, and as far as they are certain, they do not refer to reality"

The test is not about certainty or **truth**, but about practical usefulness.

→ **Mathematical truth; Objectivity; Ontological skepticism; Reality (Riddle of); Reference frame**

2326

OBJECT-IN- TIME ¹⁾²⁾³⁾

From the **phenomenological** viewpoint as presented by HUSSERL we perceive what we call "objects" only due to their relative **permanence** in time (Zeitgegenstand)

This can be compared with the way gravitational **fields** allow us to perceive space by structuring it.

More generally, we cannot definitely separate **matter** (objects"), **space**, **time** and **energy**. Anyone of these four phenomenological **percepts** is absolutely needed to make sense of the others. Their **whole** is our inevitable basic **frame of reference**.

From another- but related- viewpoint, our **brain** reflects this multi-complementary. As to the perceived time **flow**, the **hippocampus** is the seat of the **short-time memory** and the instrument of the development of the long-one. Without its **action**, we could not remember anything in a mental way. We would not benefit of what HUSSERL calls "retention".

→ **Correlation; Exclusion Principle; Interoception; Observation; Perception**

2327

OBJECTIVE ^{1) - 3)}

"... a preferred outcome ... which can be obtained over a longer **period of time**" (Adapted from R.L. ACKOFF - 1972).

As stated by ACKOFF, objectives are proper to **purposeful systems**.

He also understands that an objective encompasses a succession of intermediate **goals**: "Pursuit of an objective requires an ability to change **goals** once a **goal** has been obtained. This is why such pursuit is possible only for a **purposeful system**" (ibid).

For K. KRIPPENDORFF an objective is "the **goal, purpose** or **criterion** a **decision maker** uses to evaluated alternative courses of **actions**. The **choice** of objectives **constrains** possible **behaviors**" (1986, p.54).

In relation to his **metasystem** concept, J.van GIGCH writes: "The objectives of high-level systems will be labeled "high level" objectives; those of low-level systems "low-level" objectives. High-level objectives are not necessarily better than lower-level systems objectives...

"In a **hierarchy** of systems, it would be unusual to find that systems objectives or objectives in a **hierarchy** of objectives are independent of each other. Unless the **independence** of systems objectives can be assumed, their **values** cannot be incorporated in an **additive function**" (1978, p.376).

2328

OBJECTIVES (Multiple)^{1) - 4)}

S.S. SANGUPTA and R.L. ACKOFF consider that: "Perhaps the most important problem in the normative analysis of **man-machine systems** is the one presented by the multiplicity of objectives" (1965, p.44).

As noted by these authors, this is at least a two-sided problem: It depends on **optimization criteria** at the **management level**, but also, in not very decentralized systems, of **sub-systems** decision makers and even, in some cases, on individual participants objectives.

However, according to SANGUPTA and ACKOFF: "... it is not the existence of multiple objectives but the uncoordinated pursuit of these that typically causes **conflicts** within an **organization**". And: "The **complexity** that arises out of the pursuit of multiple objectives is due to the fact that there are **interactions** among the **goals** that are defined either for the system or its **subfunctions**" (Ibid.).

As stated by T.R. BURNS and L.D. MEEKER: "... multiple objectives cannot be satisfied simultaneously... No one course of action or outcome will maximize the achievement of – or possibly even manage to accomplish – all the objectives" (1976, p.114).

All this suggests that policies should be based on a sound **perception** by all the members of the **organization** of the objectives, not only those of the managers, but also those of the other members of the **organization**. Moreover, a good **understanding** of the global **organization** as a system and in systemic terms is a must, as well as at least a minimal **consensus**.

J.G. MILLER **taxonomy of subsystems and translevel hypothesis** could be very useful to such a discovery.

→ **Heterarchy and Holography as a metaphor**

2329

OBJECTIVITY^{3) - 4)}

The supposed capability of the human reason to observe and register reality as it is in itself.

In fact, this is a belief. For H. MARGENAU (as quoted by van GIGCH, 2002, p. 202), to EINSTEIN himself objectivity meant "the **belief** in an external world, independent of the perceiving **subject**, (which) is the basis of all natural science".

As we are all "perceiving subjects" and as such unable to escape this condition, we must unavoidably accept it as a postulated foundation for all **knowledge**. It is however clear that the postulate serves us quite well to understand and manage our surrounding **environment**...at least as long as we do not delude ourselves.

Objectivity was the bedrock of classical 19th. Century science: "The characters of the **observer** should never intrude in his/her **observations**", which imposes the absolute separation of the **observer** and the observed.

D. Mc NEIL writes: "Despite the persistent myth of perfect objectivity left over from the idealization of **mechanism** during the nineteenth Century, it has long been understood that, whether it be in quantum **uncertainty** or in social **interaction**, every **observation** is an intervention... more or less. Furthermore, it is absurd to claim that scientific endeavor is detached as long as it strives for "**prediction and control**" (1993b, p.4).

From a different viewpoint, H.von FOERSTER states that "objectivity" "... is the cognitive version of the physiological **blindspot**: we do not see what we do not see. Objectivity is a **subject's** delusion that observing can be done without him" (i.e. as an **observer**) (American Society for Cybernetics Declaration 1983).

The French economist J. FOURASTIÉ called this "ignorance of ignorance" and the Dutch systemist G.de ZEEUW developed a similar **concept** under the name of "**invisibility**".

The possibility of objectivity is indeed a **belief**, that leads to an **ontological** postulate. P. DELATTRE, (also quoted by J.L.LE MOIGNE) observes: "The very notion of objectivity is not so limpid as it seems to be. The **concept** of objectivity is closely linked with the one of more or less universal **consensus**, but this is certainly not sufficient" (1971, p.8).

This can be more or less easily done in the "objective world of classical science... subsumed as a special case of weak **interaction**" (i.e. between the **observing** and the **observed** systems) (R. GLANVILLE, 1979, p.37)

In other words, that which we call reality seems merely to mirror our most generally shared views about the equivalence of our respective **perceptions** and the interpretations that we elaborate on them: "objectivity" at its best is merely more or less enlightened and well founded agreement between shared **subjectivities**. As such, it can exist merely as "... a **systemic** property of the system of science taken collectively. Objectivity, if it results, occurs from a **process** of weeding out our conflicting claims" (I.I. MITROFF and H.A. LINSTONE, 1993, p.89).

Practical consequences in any human **activity** – scientific or other – are portentous: Presence of objectivity from the part of any **stakeholder** in any **issue** is merely either ignored **subjectivity** or, worse, a attempt to silence anyone proposing different views.

Also C.W. CHURCHMAN came to the conclusion that, as **subjectivity** can never be excluded, it should be included in any definition of objectivity (1971, p.169-72).

We are led in this way to **ontological skepticism**, which does not deny the existence of objective reality, but considers that is only possible to know it in a relative way, through more or less shared **models**, ever susceptible of further revisions.

This is of course the lesson of the whole history of science and, still more generally of human reason.

2330

OBJECTS OF REFERENCE¹⁾⁵⁾

"Virtual objects **representation** (that) becomes the **references** to anchor the **path** of intentional movement and to bind the visual **constancy** in object **perception**"(C.A. STECKNER, 1999, p. 101)

Objects of reference are obtained through a "**mapping process** (that) cuts the **action-relevant** external object qualities from the **environmental background** to constitute the needed true objects of reference within the **organization** of the personal **space**"(Ibid.)

A good example is the way the driver observes a red traffic light, awaiting its switching to green to proceed on his way.

The rest of the scenery recedes from his intended perception, but his attention focused on the traffic light is simultaneously **anticipatory** and **intentional**. It is a step in the construction of a complex **sequential behavior**

→ **Intentionality**

2331

OBLIVION EFFECTS¹⁾⁵⁾

There is a progressive erosion of **memory** in systems.

Two aspects seem most important:

- 1- No system has an unlimited capacity for memorization. It will tend to remember only that which has been repeatedly useful for practical **purposes** in its **behavior** (**HEBB's rule**) However, **long-term memory** may retain for very long time some unused **information**
- 2- In complex systems the **sensibility** to remembered **initial conditions** may lead to **chaotic behavior**. Losing memory of these **initial conditions** may deeply alter the behavior of the system

2332

OBSERVABILITY (Constraints on)³⁾

M. NOWAKOWSKA states (1986, p.52-4) as follows the observability problem: "The **phenomenon** to be observed is assumed to be described in terms of n **attributes**, say $y_1...y_n$. To determine the **state** of the **phenomenon** at any given **time**, one needs to know the **values** of all **components**."

"The constraints on observability may be of three types. Firstly, it is quite common that **values** of a given **variable** can be known only up to some precision" (p.52).

Practically this is *always* the case. For this reason, as noted by this author, it is generally necessary to use statistics. But in this case, it is implicitly admitted that a mean between **observations** of many similar **states** of many similar **phenomena** can validly be used.

"Another kind of restriction on observability is of conditional character: it is typified by a constraint that, if y_i assumes a **value** in some **range**, then one cannot observe the **value** of variable y_j ... In practice such situation occurs when some **values** (usually the extreme ones) cannot be observed at all, or prevent **observations** of some other **variable** or **variables**" (p.53).

"Finally, the third type of constraint concerns joint observability; it is typified by the situation where y_i and y_j may each be observed, but not jointly" (p.53).

This is basically the **indeterminacy** (or **uncertainty**) problem, very basic at quanta level.

"Of course, all three kinds of constraints may operate at the same **time** in a given **phenomenon**" (Ibid).

The use of the concept of "**state** of the **phenomenon**" clearly shows the fundamental **ambiguity** of any **observation**, that is always trying to "solidify" a dynamic succession of **events** into a sequence of static **states** (sorry for the pleonasm!).

In synthesis, even leaving aside physiological limitations, we are always trapped within our mental **dichotomy** between **time** and **space**.

2333

OBSERVATION (Conditions of)^{2) - 3)}

At our **macro-level** the observing act does not affect *sensibly* the observed (so-called) **object**. In any case, the **perturbation** produced by the observing act is normally infinitesimal and even generally escapes any possible **measurement**. However, this is true only for physical observations at **macro-level**, but not for **micro-level** ones.

In a different sense any mental component in an observing act modifies the **perception** of the so-called **object**. The **observer** and the observed thing or **event** can never be completely and clearly dissociated (S LUPASCO, 1972, p.104).

As stated by H.von FOERSTER, we thus need "an observational **epistemology**" (1992, p.44).

At least the following aspects should be taken care of:

- intentionality of the **observer**
- physiological limitations of the **observer**
- psychological and cultural bents (**mind-scapes**) of the **observer** (conceptual **organizational closure**)
- selected **level** of observation (grossly: **micro-, macro- or mega-**)
- characteristics of the observational device used. (these show us what their construction allows for and we translate according to our **knowledge** of their characteristics)
- **paradigmatic** orientation of the **observer** (for ex.: mythical, mechanistic, **reductionist** or **holistic** bent)

K. POPPER recognized the same situation: "The belief that we can start with pure observation alone, without anything in the nature of theory, is absurd... Observation is always selective. It needs a chosen **object**, a definite task, a point of view, a **problem**. And its **description** presupposes a descriptive **language**..." (1981, as quoted by M. DODDS and G. JAROS, 1994).

2334

OBSERVATION PROCESS: A Constructivist Interpretation³⁾

F. HEYLIGHEN explains: "In a realist interpretation, a **state** is an intrinsic property of a system, which is independent of the **observer**"... This may indeed be correct per se, but it is of no practical use, since "...In a **constructivist** interpretation, a **state** is a **construct** resulting from an **interaction** between the system and the **observer**, which is such that it allows the observer to find a maximum of **coherence** between the different results of observations (i.e. **subject-object interactions**). In general, no construction (**representation**) is optimal, and the advantages and disadvantages of a particular **representation** may be counterbalanced by different advantages and disadvantages of another **representation**." (1990b, p.498).

2335

OBSERVATION (Self)¹⁾³⁾⁴⁾

In the tracks of SOCRATES, E. MORIN states that we need a rationality that be not only critical, but also self-critical.

He writes: "**Learning** of self-observation is part of learning lucidity" 1999 (p. 55). If we cannot do it, we are condemned to self-deception in the guise of very "imperfect **perceptions** and hallucinating rationalizations"(ibid.)

Of course, the basic condition for self-observation is the acquisition of **awareness** under the guidance of systemic understanding of our own **complexity** (biological, mental and psychological) and of our interrelation with our natural and **socio-cultural** environment.

Self-observation by the **observer** is certainly a most needed endeavor...and at the same time probably the most difficult; as so many people are loath to question themselves.

It is however a systemic and cybernetic absolute necessity. We need a permanent **revaluation** of our views and **frames of reference**. And this amounts to a mental and even more difficult psychological disjunction from ourselves.

We would need **feedbacks** on our own thoughts and **decisions**, in order to try to avoid being puppets of ourselves (and, by the way, of other people)

This should start by self-inquiry, answering questions as for instance:

- why do I (drink, smoke, quarrel, etc.)?
- why did the results of this or that **decision** be so adverse?
- in which way did I misunderstood this **issue**?
- why is this fellow so hostile to me?

We should always remember J. FOURASTIE's comment: "There is something worse than ignorance; it is the ignorance of ignorance". And still worse is the ignorance of the causes of ignorance.

What we need basically are mental, behavioral and even physiological feedbacks to ourselves. If we don't know how to create and understand them, we cannot become good systemists, nor managers of ourselves or anything else.

→ **Autopoiesis; Behavior (Self-organizing); Cybernetics (2nd Order); Double-bind; Psychology (Systemic); Self-exception fallacy; Self-reference**

2336

OBSERVATION: The autopoietic view²⁾³⁾

O. THYSSEN (1995, p. 20) explains as follows the nature of **observation**, as understood by N. LUHMANN, in his **autopoietic** interpretation: "LUHMANN does not base his systems theory on **ontology**, but on **distinction**. Even being, or what is observed as real, is a distinction between being and not being.

"In **observing**, **autopoietic** systems use **codes** to distinguish between positive and negative values of a distinction, artificially doubling the world (+/-, true/false, government/opposition, good/bad)... They use **programmes** in order to distribute the +/- **values** of the **code** to positive and negative prototypes. And they use **interpretations** in order to link the prototypes to real world **events**"

Moreover:

"Any **observation** is based on the fundamental **distinction** between **self reference** and external **reference**. The two types of reference imply each other so that no **materialism** (only external reference) and no **idealism** (only self-reference) is possible. At the same time, the system **environment distinction** is an *internal* distinction, as no system can operate outside

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

itself. So, the world is at the same time "out there", as external reference, and "in here", as the re-entry of the distinction system/environment in the system.

"The "world" is a borderline concept which cannot be negated"

→ **Model; Models; Recursion; Recursivity**

2337

OBSERVATION WINDOW²⁾

T.H. F. ALLEN and T.B. STARR explain: "... an observation window is determined for a given observation principally by the extent in **time** and/or **space** of **integration** used by the **observer** as he observes" (1982, p.274).

2338

OBSERVATIONAL LANGUAGE^{3) - 4)}

The descriptive and interpretive language a culture uses during some period of its **evolution** to connect itself with **reality**.

This concept has been established and discussed by G.de ZEEUW, who describes it as a **set** of **rules** which state **constraints** in the way the **observations** are done, registered, ordered in some coherent mental **frame of reference** and communicated among members of the culture (1992).

Of course "... the observational language limits itself...by imposing **models** on the actors in an **interaction**, that is, imposing **criteria** for **interaction**" (Ibid.,p.1077).

As a result, no observational language gives an unrestricted access to **reality** and always leads to the impossibility to observe certain **situations**. As no language is perfectly transparent, there always some measure of "**invisibility**" (de ZEEUW's terminology).

de ZEEUW states that the observational language evolves through time, generally under the pressure of new necessities. He argues that we find ourselves in such a period of **transformation** of the observational language, in relation to the emergence of numerous new features in science and cultures.

The same point what made in a quite different way by the French philosopher M. FOUCAULT (1966).

The slow shift of observational languages, of which we are generally unaware, is probably universal and permanent.

2339

OBSERVER¹⁾

Any percipient **organism** able to acquire a degree of awareness and obtain some **understanding** of its **environment** and **invironment**.

The first who emphasized the peculiar situation of the observer was R.J. BOSCOVICH in his "De Spatio et Tempore" (1758). In R. FISCHER's words: "BOSCOVICH claimed that the observer can never observe the world as it is – only the **interface** (or difference) between him and the

world... the observer does not see the world as it is: only a "transform", that depends of his own **state** of internal motions, will be accessible to him in principle" (1991, p.96). Basing himself on experiences on sensory attenuation, FISCHER ends up with a "principle of neurobiological relativity", according to which "**changes** in **states** of **consciousness**... reflect perceptual-conceptual **adjustments**, i.e. relativistic **transformations** to the changing ratio of internal vs. external excitation" (p.99).

An observer always selects some **elements** from the **set** of all possible (for him/her) **observations**. He/she is thus what J. WHEELER (quoted by F. DAVID PEAT, 1988, p.37) calls a "participator". Why and how this **selection** is made, is a very basic foundation for the ulterior use, **reliability** and **validity** of the obtained conclusions. The weight of the "participator" in the **observation process** depends, under other aspects, on his/her relative **size** in relation to the observed **phenomenon**: this explains, for instance, why celestial mechanics looks so "**objective**". But there are also physio- and psychological distortions. These became a serious concern for all thoughtful systemists and cybernetists.

In synthesis: "... in making an **observation**, the observer is operating as a cybernetic **control** and **communication** system for the observed system" (R. GLANVILLE, 1979, p. 37).

In turn, the observed system reacts to the observation act. Thus the observed system "can no longer be thought as an independent and isolated system in the classical scientific sense" (Ibid).

The permanent use of some controls may provoke a progressive **resistance** of the controlled factor. This has been observed in the numerous cases in which a parasite or pathogen evolved new strains, resistant to ever-growing doses of the control drug.

A way out of this problem could be the application of the control factor in an irregular way in **time**, thus avoiding the constant exposure that leads to pest resistance. Another way is to apply the control factor only when a **threshold** of infestation is crossed.

This **model** could be useful every time a **control** is proposed in a naturally fluctuating **situation**.

H.von FOERSTER, and H. MATURANA and F. VARELA developed a systemic-cybernetic concept of the percipient conditions of any observer. According to this viewpoint, an observer perceives *basically anything* in **function** of her/his own internal **organization**, physical and/or cerebral-mental.

According to von FOERSTER: "Qualities that we believe finding in **objects** lie within the observer". As an example, he uses: "Obscenity: I show a picture to somebody and ask him if it is obscene. He says "Yes". As a result, I now know something about him, but not about the

picture" (1992, p. 85). We must however start by believing that the picture does exist! In any case, as noted by J.J. GIBSON: "The observer and his **environment** are complementary. So are the **set** of observers and their common **environment**" and "The **environment** persists in some respects and changes in other respects. The most radical **change** is going out of existence or coming into existence" (1986, p.15).

Moreover, we need to find out how these Foersterian "qualities" came in existence within the observer and even how the observer himself came into existence. The **autopoiesis** and **organizational closure** concepts give merely some inklings into these topics.

Another theory of the observer has been developed by G. JUMARIE (1980). Its basic features are:

- Any system can be defined only in relation to a given observer. Thus the **same object** would be perceived differently by different observers;
- An observer receiving **information** from his/her **environment** uses it to modify his/her internal **structure**. JUMARIE comments: "This axiom merely systemize the fact that all systems are more or less **adaptive**".
- To a higher degree of **knowledge** that an observer has of his/her **environment** corresponds a higher capacity to extract **information** from it.
- Any **universe** is blind to itself, i.e. unable to observe its own **transformations**. According to JUMARIE, this proposition is equivalent to **GÖDEL's theorem** relative to the **incompleteness** of the formal systems.

All this, when duly pondered, is more or less subtly related to the **organizational closure** concept.

2340

OBSERVER (Collective)¹⁾³⁾⁴⁾

According to K. BAUSCH, "the concept of **observer** may be considered at three **levels**

- 1- as generator of **relativity**, of **subjectivity**
- 2- as architect of **models** of other systems
- 3- as multi-systems having **components simultaneously** belonging to more than a single system, making different systems emergent even contemporaneously, such as occurs in flocks, **swarms** and social systems" (Glossary-Pers. comm., 2002)

So called collective observers are in most cases also collective actors, **agents** or **operators**. In fact, the model could be applied to all collective **behaviors**.

However such behaviors are frequently quite unstable (or even fickle): flocks, **swarms** or **crowds** are easily broken up...and reordered in a different way

In the case of crowds they are notoriously inconstant, unpredictable or apt to be manipulated (a good example is Marc Antonio's discourse to the roman crowd after the murder of Julius Cesar, in SHAKESPEARE's drama)

In fact there is always a shifting and unstable behavioral relation between any individual and the crowd he/she happens to mix up at any time.

Membership itself is frequently dubious and provisional. A reconsideration of the proposed concept in the light of **autopoiesis**, **conversation** model and **structure coupling** seems to be necessary

2341

OBSOLESCENCE ^{1) - 4)}

The characteristic of an **artifact** or technique which cannot anymore compete with more efficient newer ones.

Obsolescence started being merely a result of moderate technical **evolution**, as for example, for stage coaches being slowly replaced by motorized vehicles, or transoceanic liners by airplanes.

However, it is now a much more intricate systemic problem. First, capitalist economic dynamics introduced covert "planned obsolescence" as a way to foster early renewal of durable **artifacts**.

Now, the acceleration of technical progress is generating "non-planned obsolescence", as still very usable and not yet duly written-off **artifacts** are turned non-cost effective by new appliances.

The classical **model** of **life-cycle** is consequently no longer valid. As a result obsolescence must now be considered a **time-binded** systemic **situation** that introduces new types of **constraints** (and **stresses**) in economy and in society, which should become a subject of research.

2342

OCCUPANCY RULE ⁴⁾⁵⁾

The number of species able to maintain themselves in a specific area grows logarithmically in proportion to the area. (E.O. WILSON, 2000, p.15)

While this is originally an ecological one, it can be considered as a very general systemic occupancy **rule** since it corresponds to the growing number of permutations of the possible relations between a growing number of **elements** of some specific related kinds, as related to the diversifying **carrying capacity** of the area.

It is obviously valid for human establishments at different **levels**, from a small village to a great metropolis, and even the planet as a **whole**.

→ **Space Syntax**

2343

Ockhams' RAZOR ¹⁾²⁾³⁾

The exigency to explain any result - experimental or conceptual - using the smallest possible number of **concepts**. (Adapted from P. CHECKLAND, 1976, p. 28)

This method and philosophical principle is attributed to William of OCKHAM, the 14th Century's english monk philosopher.

The principle can be applied to "**top down**" **explanations** as well as to "**bottom up**" ones. This means that it should not be invoked to justify exclusively **reductionist** or systemic-holistic viewpoints. These in fact reflect an **asymmetrical complementarity**.

While very different, Ockham's Razor could be compared with G. CHAITIN's "**algorithmic complexity**", both are inquiries into the nature of simplicity in explanation.

Anyhow, some aspects of Ockhams's Razor should be scrutinized in a closer way:

- The most simple is not generally the most immediate ... and the most immediate is frequently not the most simple

- In the words of A. RAPOPORT: "Seek simplicity, but distrust it"

The most simple **explanation** may in some cases hide some unsuspected aspects, in need of some more complex **modelling** or **description**.... which could be the most simple, but at a wider or deeper **level of understanding**.

We may also seek and understand **simplicity** either at the typically **reductionist** or, on the contrary, at the **wholeness level**.

2344

OLIGOPOLY STATES (Law of) ^{1) - 2) - 4)}

"If there are competing **organizations**, the **instability** of their relations and hence the danger of frictions and **conflicts** increase with the decrease of the number of those **organizations**." (L.von BERTALANFFY, 1956, p.8).

This law, which was first stated by V. VOLTERRA (1931), is applicable for example to competitive **populations**: thus ecological systems with numerous complementary species are more stable than those which count with only some few (This is why monocultivation brings along so many problems). VOLTERRA showed that in systems scantily diversified, destruction of the prey species by the predatory can lead to the disappearance of the latter altogether, due to the lack of any alternate **resources**.

The application of the law to economical oligopolies is not so obvious, but would be an interesting subject for scrutiny. Moreover, while **conflicts** between a reduced number of very big **organizations** can be very costly, it should be interesting to consider other aspects as for example the total costs of numerous small local

conflicts between **organizations** of a lesser **size**, or what could be the significance of a prey-predator analogue relation between differentiated **organizations**.

2345

OLYMPIAN STANCE ³⁾

The position of a researcher that imagines him/herself in an absolutely separate and objective position in relation to the **object** of his/her research.

This attitude is also known as self-excepting fallacy. Such stance ignores the various perceptive **limits** that obstruct our full **knowledge** of reality. It also ignores our internal perceptive and cognitive **organizational closure** that conditions our concepts formation, mental **frames of reference**, **models**, viewpoints, psychological biases, etc...

The Olympian stance leads easily to mind blocks, illusory **objectivity** and even intolerance for others' opinions.

This expression was introduced by the anthropologist G. DEVEREUX

→ **Blindspots**

2346

ONTOGENESIS ^{2) - 5)}

The **process** of **self-organization** of a biological system, starting from an initial **structure**.

E. JANTSCH defines the very similar term of "ontogeny" as "the **evolution of self-organizing space-time structures** in a coherent way through **changes** in the dynamic **regime**" and adds that "It arises from **dissipative self-organization** which, in principle, defeats any structural permanency (NICOLIS and PRIGOGINE, 1977) and may be interpreted as **dynamical self-reference** - not with respect to a single **structure**, but with respect to an evolutionary **path of structures**. The system is **self-referential** in terms of its own **evolution**" (1982, p.344).

It would be interesting to translate the concept into the study of animal and human societies: How do they organize themselves in coherent **complex systems**?

2347

ONTOGENY ¹⁾⁵⁾

"The **process** of **development** of the individual: embryology plus whatever changes in **environment** and **habitat** may impose" (G. BATESON, 1979, p.229)

The interesting point thus made clear is the importance of the direct and indirect (habitat) impacts on the original **structure**.

But does the ontogenic **process**, as thus understood, finally ends at some precise **time** in the system's life?

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

2348

ONTOLOGICAL SKEPTICISM or AGNOSTICISM³⁾

Classical science is founded on the firm belief in our possibility to observe nature in an objective way, which is not the same as the postulate about the objective existence of nature.

The difference lies in the classical standpoint that ascribes an absolute **objective value** to the observed "**facts**" without being aware that these "**facts**" are *constructed* through perceptive and conceptual **filters**, in accordance with human physiological and cerebral *characteristics*.

This point – already made by BOSCOVICH in 1758, in his "De spatio et tempore"!, as quoted by R. FISCHER (1991, p.96) – is neatly stated by E.von GLASERSFELD: "The fact that we can coordinate our own sense **data** (very low-level mental **structures**) into recurrent **structures** (low-level mental **structures**) can never prove that these **structures** are ontologically real – it only proves that the individual **data** occur frequently enough in our experience for us to establish *invariant* co-occurrences" (1988, p.13).

von GLASERSFELD himself quotes this significant paragraph in L. WITTGENSTEIN's "Tractatus logico-philosophicus": "In order to discover whether the picture is true or false we must compare it with reality (...). How could one possibly carry out that comparison?"

And he concludes in a rather radical way: "Ontological **reality** is a matter of belief" (1991, p.115)

According to M.C.LE DUC "mental **structures**" should be understood as concrete **structures** in the nervous system" (1992, p.918). We cannot know anything if not in a physiological way.

This also justifies A. EDDINGTON observation that we only can see what our **epistemology** allows for, i.e. on the base of the value we recognize to our own **perceptions**.

It seems anyhow natural and even unavoidable to *postulate* the objective existence of nature (i.e. our **environment**). E. SCHWARZ writes: "... human **knowledge** is a gradual human construction, shaped in **interaction** with the **environment**; it is thus a co-construction which reflects the **attributes** of the knowing **subject** as well as these of the **object of knowledge**" (1994, p. 582). It is thus certainly foolhardy to attribute an absolute **value** to that which we believe we know about our surroundings.

Similarly, St. KATZ observes that: "Though the **subject** may attach ontological significance to the items it knows, those who see the **subject-environment relation** within the framework of **neural computation** believe differently" (1976, p.44).

Ontology of **knowledge** is definitely a slippery subject. The systemist seems thus doomed to a prudent ontological agnosticism or skepticism, but should avoid nihilism altogether (FEYERABEND's for example).

2349

ONTOLOGY (Constitutive) (H. MATURANA's)³⁾

R. HARNDEN explains constitutive ontology in this way: "Instead of making claims to go beyond or transcend **understanding** by pointing toward eternal, immutable verities, a constitutive ontology rest its claims for reality with whatsoever is brought forth by the individual **observer**, in the course of the **consensual** coordinations of **actions** in a **community of observers**" (1990, p.294).

"When used as a synonym for "**objectivity**", ontology is ascribed a transcendental status. It suggest something over beyond what is known, something that might be referred to as Reality or as **Truth**. This Platonic legacy is what is denied by MATURANA's insight into a constitutive ontology. When we place **objectivity** in brackets, we are left with a world or better, a series of individual **cognitive spaces**, in dynamic relations with one another and the global **environment**." (Ibid, p.294).

and finally...

"No statement for or against **Objectivity** is being made." (Ibid.).

When one objectivizes in an absolute way, what he/she really does is create a theater of ghosts, with a dangerous potential for self-deception, illusory **idealization** and, easily, ideological intolerance.

2350

OPENNESS²⁾

The more or less free **flow of matter and energy** from the **environment** into the system and vice-versa.

A. COLLEN et al (1994, p.65-68) make the following relevant points: "Most **concrete systems** have **boundaries** which are at least partially permeable, permitting sizable **magnitudes** of at least certain sorts of **matter-energy** or **information transmission** to cross them. Such a system is an **open system** (in which) **entropy** may increase, remaining in **steady state** or decrease. The classical notion of openness can be named the **thermodynamic** one..."

"A system can be opening or closing, which emphasizes the **processes** of the system.

"With respect to the **hierarchy** a system can be open or closed at different **levels**..."

The authors distinguish various types of openness: passive or active; tactic or strategic, and establish a table comparing closedness to openness, as follows:

"From closedness

Passive
Insensitive to its **context**
No learning
Object-oriented
Inflexible
No changing of **rules**
Avoiding contradiction

to openness

Active
Sensitive to its **context**
Learning
Process-oriented
Evolving
Changing of **rules**
Using contradiction to evolve
Generating multiple hypothesis
Inductive
Cannot be disassembled and reassembled
Inclusive of the **observer**, who is inside the system

2351

OPERAND²⁾

An **element** on which an **operation** is performed

The **element** can be material or abstract, simple or complex.

2352

OPERATION²⁾

"A basic **process** that applies to an **operand** and yields a transform" (K. KRIPPENDORFF, 1986, p.54).

KRIPPENDORFF gives as examples "the multiplication of two numbers, driving a nail with a hammer, baking" (Ibid).

R. ACKOFF gives the following descriptive definition of the term: "Loosely put, a **set** of acts can be said to constitute an operation if each act is necessary for the occurrence of a desired outcome and if these acts are interdependent. The nature of this **interdependence** can be precisely defined. The relevant outcome involved in an operation can each be defined by a **set** of properties which can be treated as **variables**" (1960, p.2).

ACKOFF wrote this in 1960. One wonders if this quite deterministic attitude, proper at the time of **operations research** could still be maintained nowadays in view of what we are learning from **chaos theory** (even in man-managed systems), particularly in systems with various and more or less independent **initial conditions**.

2353

OPERATION LAG¹⁾

The **time lag** "caused by the actual functioning of the **components**" (R. ROSEN, 1966, p.39).

R. ROSEN distinguishes operation lags from transport or other **lags**, which results of **delays** in the **transmission of effects** between **components** or **subsystems**.

He explains that: "If a **component** produces more than one **output**, then each of its **outputs** will have its own operation lag. Further, in the most general case, the **time** required for a **component** to produce an **input** depends on the particular **input** materials with which the **component** was supplied" (Ibid).

Like any **time lag**, the operation lags introduce **heterogeneity** in **space** and **time** into the system. This can be damaging or, on the contrary, useful for its **coherence**.

Different operation lags normally introduce a certain **indeterminism** into the system.

2354

OPERATION RESEARCH⁵⁾

L.von BERTALANFFY gives the following definition: "Scientific **control** of existing systems of men, machines, materials, money, etc..." (1962, p.3).

St. BEER, in "Decision and Control" is quite cautious and recoils from any limitative definition. He prefers to describe what O.R. does: "Operation research is the attack of modern science on complex problems arising in the direction and **management**...- of what exactly?" His reply is "Of enterprises" but he immediately ask himself: "What is really an enterprise, as seen from the scientist's viewpoint?" (1968, p.89).

BEER's subtle view is systemic-cybernetic in the most complete sense, since O.R. must construct **models** and that no **models** of **complex systems** as enterprises or **organizations** can be constructed (and put in perspective) without the help of multiple systemic and cybernetics concepts.

O.R. uses tools such as **linear programming**, **games** and **computer simulations**, developed through specific theories thus enumerated by R. ACKOFF: "...allocation, queuing, sequencing, routing, replacement, competitive, and search theories" (1974 b, p.57).

R. ACKOFF describes O.R. in the following terms: "The essential characteristics of this **interdisciplinary** activity lie in its **methodology**. Out of an analysis of the desired outcomes, **objectives** of the **organization**, it develops a measure of performance (P) of the system. It then seeks to **model** the **organization's behavior** in the form of an equation in which the measure of **performance** is equated to some **functions** of those aspects of the system which are subject to **management's control** (C_i) and which affect the desired outcome, and to those controlled aspects of the system (U_j) which also affect the outcome.

"Thus the **model** takes the form:

$$P = f(C_i, U_j)$$

"From the **model**, values of the **control variables** are found which maximize (or minimize) the measure of the systems performance:

$$C_i = g(U_j)$$

"The solution, therefore consists of a set of **rules**, one for each **control variable**, which establishes the value at which that **variable** should be set for any possible **set** of values of the uncontrolled **variables**" (1974, p.5).

Operations research has proved quite useful in numerous cases. However it knows of severe limitations, as stated by ACKOFF, himself a recognized leader in O.R.: "It will be recognized that this procedure is one by which equipment systems should be ideally designed... Unfortunately, in many cases such a **model** of a desired equipment system cannot be constructed because of our ignorance... Nor is there sufficient **knowledge** to relate any of the less perfect available measures of **performance** to the large number of **design variables**... As a consequence, **design** is currently accomplished by a combination of scientific analysis, intuition and aesthetic considerations".

Even so, in his 1960 paper, ACKOFF was optimistic: "It should be recognized however, that current **design** procedures are only an evolutionary stage which will be replaced as rapidly as possible by effective **modelling** and the extraction of solutions from the resulting **models**" (Ibid).

ACKOFF himself later contributed with his **interactive** or participative **planning** a new approach that tries to mend some of the O.R. problems.

However, more than 30 years later hopes for better solutions seem to have been at the same time furthered and dashed with the development of **chaos theory** and **thermodynamics of the irreversible systems faraway from equilibrium**: **Complex systems' behavior** can never be forecasted in a perfectly accurate way. However, the limits to **predictability** are now better understood.

On the other hand, one of the first O.R. enthusiasts, C.W. CHURCHMAN, recognized in 1979 (as quoted by M.C. JACKSON, 1992, p.255) "that the original intention of a **holistic, interdisciplinary** experimental science adressed to **problems in social systems** was betrayed as O.R. degenerated, in the 1960s, into little more than mathematical **modeling**".

Many practitioners would even be surprised to learn that it was ever intended to be more than that!

The practically insoluble difficulties encountered by FORRESTER's **world dynamics** were a early harbinger of this situation.

2355

OPERATIONAL RESEARCH (OR) reconsidered¹⁾²⁾

In a recent article, I. MUNRO reconsiders the history and the present state of organizational research (1999, p. 513-532)

As to the historical aspects, after retracing the origins of OR during World War 2, he argues that it quickly derived into a mechanized view of **reality**, even if most research teams included people from many disciplines.

The basic six-stage recommended **methodology** was as follows:

1. Formulate the problem
2. Construct a mathematical **model** to represent the system under study
3. Derive a **solution** from the model
4. Test the model and the solution derived from it
5. Establish **controls** over the solution
6. Put the solution to work"(p. 516)

Of course, such a **methodology** is highly formalistic and **mechanistic**, specially when the "problem" is considered without any reference to the many human aspects (developed -for ex.- in J. WARFIELD's Generic Design).

MUNRO states: "(the) models tend to be constructed entirely from things that have been quantified and measured"...which is fine when the "problem" is for ex. the build-up of a new production line for a new car model (in a non-technical and human **environment** whose **stability**- or even asepsy!- is taken for granted)

MUNRO proceeds with a study of the cultural settings which led to this kind of OR, including economic and social biases that become even clearly reflected in **language** (p. 518)

He then retraces the advent of more integrated views in so-called "soft OR" and refers himself to authors like CHURCHMAN, ACKOFF and CHECKLAND and goes so far as quoting Samuel BUTLER's "Erewhon": "May not man himself become a sort of parasite upon the **machines**. An affectionate machine-tickling aphid?"(p. 521)

Finally, it shows clearly that man-machines systems classical OR is much more about machines than about men. As a result we should remember ACKOFF's quip about "doing perfectly things that should never have been done in the first place"

MUNRO advocates in the last part of his paper for reworking of the basic idea of **man-machine system**: Men use machines and the ways machines are used- or could, or should be used - cannot be ignored in soft OR. He quotes MINGER'S approach according to which "...problem solving in the real world does not simply involve finding the right **code** of conduct or the right **methodology** to suit the circumstances, but requires that questions be asked about the experience of the **agents** involved, their past history and their various commitments" (p. 529) and the need to discuss "technologies of the **self**".

One wonders if such a new kind of OR does not totally escape the limits of the technical **aims** and tools of OR itself. Again, J. WARFIELD (and other authors like ACKOFF, MITROFF and LINSTONE and CHECKLAND himself) seems nearer to the point with his **Generic Design**.

2356

OPERATIONALISM

A philosophical doctrine holding that the **meaning** of a **concept** can be defined only by a set of actual experimental **operations**.

In its most radical interpretation, operationalism demands that such operations be measurable.

From a systemic view point, this seems to be too restrictive, as it prohibits not only **metaphors** or **analogies** but altogether seemingly qualitative **models** as for example **topological** ones.

It is also quite difficult to see how the traditional **frame of reference** of thought in general **-logic** for instance- can be redefined in operationalism terms.

But the unending-and many times doubtful, if not contradictory-meanderings of all kinds of philosophies undoubtedly explains and justify the need to find a stronger bedrock for thought.

Accordingly the basic tenet of operationalism is the need to find a way to eliminate all concepts that cannot be connected to some empirical **reality**. This exclusion apply mainly to those "ghostly" internal psychological concepts whose meaning is perpetually controversial because of their more or less imaginary, or limit-edly cultural, or imprecise character.

The main root of operationalism is in Ch.S. PEIRCE (1839-1914) original version of **pragmatism**. However, its principal proponent has been the american physicist P.W. BRIDGMAN (1882-1961)

H. MATURANA and F. VARELA's views about the ways of **cognition** and its autopoietic character ("**Santiago theory**") reset the whole of operationalism in a new light: Cognition may never become really measurable, but at least it is becoming more rationally- and "operationally"- understandable

2357

OPERATIONISM³⁾

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2358

OPERATOR²⁾

"A **transformation** or **transition rule** mapping initial **states** upon subsequent **states**" (F. HEYLIGHEN, 1990a, p.426).

The operator determines "... a **time-parametrized trajectory** in the **state space** representing the **states** of the system at subsequent instants" (Ibid).

The **concept** of operator is close to the one of **algorithm**. An operator is a specific part of an **algorithm**. Its total or partial activation at some moment depends on the **dynamics** of the **constraints**.

"An operator corresponds to a **distinction** between the **state** before the operator was applied and the **state** afterwards" (Ibid).

In a **recursive machine**, as for instance a **TURING machine**, the operator is the significant **element**, not the **input**, which is merely the **trigger**. The **input** must however be "legible" by the operator.

The previous comment suggest interesting parallelism with human "operators".

J.L.LE MOIGNE advocates for the development of a specific notation for different types of systemic operators, as for example:

- the **recursion** operator, proposed by E. MORIN
- the **distinction** operator (G. SPENCER BROWN)
- the **autonomy** operator (F. VARELA)
- the **combinators** (H.B. CURRY)

He also mention the conservation **symbols** used by J. FORRESTER in his **Systems Dynamics** (1990, p.115).

2359

OPERATOR (Decision)²⁾

A decision **process** operated by a system in correspondance with its **observation** of the **set** which includes its **environment** as well as itself.

R. VALLÉE, who introduced the concept, writes: "If we want to model the decisional **process** which follows the **observation process** (**processes** which are artificially separated for intellectual commodity but, in fact, are only one) we must go on from y , a **function** describing the **evolution** of **perceptions**, to **function** z describing the **evolution** of **decisions** or **controls** decided at each instant (in a way considered here as automatic for the sake of simplification) which must act upon the **effectors**: $z = D(y)$ where D is a **decision operator**" (1990, p.40).

Considering that y represents what the system perceives through the **observation operator** (a "distorted and impoverished image" of the real **situation** and its **evolution**) we have thus $z = D(O(x))$.

VALLÉE calls this product the **pragmatic operator**.

2360

OPERATOR (Difference)^{1) - 4)}

The use of observed **differences** to distinguish and construct **classes** and **categories**.

D. DUBOIS observed that the first ability used by the small baby is the capability to recognize a **difference** between two **objects** of its **environment**.

Later on the baby becomes able to make multiple discriminations and finally to register similarities between different **objects**. In this way it acquires the ability to sorting out multiple discriminations and start to establish in this way hierarchical **classifications**. (1991, p.5).

2361

OPERATOR (Observation)^{2) - 3)}

Observation process operated by a system on itself and on its **environment**.

The observation operator, traduced into a mathematical formalism created by R. VALLÉE (1951a, p.1350-1; and b, p.1428-9; 1987c, p.460-2; 1995, p.35-58 and 71-82) is used to define the observation **limits** characteristic of an observing system.

R. VALLÉE, who introduced the concept, states: "The **object** considered here is the very **evolution** of the system and its **environment** which cannot logically be separated, an **evolution** which is described by **function** $x : t > x(t)$ where t represents an instant. The distorted and impoverished image of x , which the system perceives, is **function** $y : t > y(t)$: being understood that, at instant $ty(t)$, *what the system believes is* $x(t)$, representing the pair constituted by the **state** at instant t , of the system and the **state**, at instant t , of its **environment**" (1990, p.39).

It emerges from this that what the system believes it knows is in fact an imperfect **model** of the objective **situation**. It is, in VALLÉE's terms a case of "**epistemological subjectivity**".

A system may have various observation operators, corresponding to different interrelated **subsystemic functions**. VALLÉE describes the rules of observational **interactions** between 2 or more observation operators (1995, p.37-8) by combining a memorization operator, a decisional operator and an acting (or effecting) operator. This **set** describes globally in mathematical terms all possible **interactions** between the system and its **environment**, leading to what VALLÉE calls the "**epistemo-praxeological loop**". Interestingly, he observes that he thus reformulates the basic epistemological **meaning** of PLATO's Cave.

→ **Transfer (Inverse)**

2362

OPERATOR (Pragmatic)²⁾

A **process** operated by a system on itself and on its **environment**.

R. VALLÉE, who introduced this concept, explains that the pragmatic operator is the product of the **observation operator** and the **decision operator**, i.e.: $P = D.O.$

The system is limited and directed in its **action** by the "distorted and impoverished" character of its **perceptions**, on which it must ground its **decisions**.

2363

OPERON⁵⁾

A biological formal unit of **control**.

This concept has been introduced by the French biologists F. JACOB and J. MONOD, to explain dynamic **coordination** in biological systems.

While related to the **neural net model**, significant differences are pointed out by R. ROSEN: "It must be stressed that the operon is a purely formal unit. It is not a physical particle, nor is it composed of such particles. It cannot be isolated physically from the cell to which it belongs. It is thus not like a neuron in a **neural net**" (1979, p.182).

This opinion may now seem unduly restrictive in the light of the discovery of "homeoboxes" (very similar in mammals as well as in insects), i.e. groups of genes on specific chromosomes, which act as coordinated and sequential organizers of the whole **living system** (W. GEHRING, 1995, p.58-64).

Operons correspond thus to the potential properties of this kind of global basic **templates**, which remained astoundingly stable during eons of **evolution**.

Operons and homeoboxes introduce the intriguing question of the possible existence of a still more general systemic organizing principle active through different ways in systems of all kinds.

(For more discussion of this difficult notion, see references)

→ **Autogenetic system precursor; Meme; Replication and Zero System**

2364

OPPOSITES (Union of)²⁾

The character of **interrelations** that are at the same time **antagonistic** and **synergetic**.

Such a view disregards the traditional mutually **exclusive** character of opposites, which merely reflects the very strongly **dichotomic** bias in Western philosophy.

H. SABELLI and L. CARLSON-SABELLI write: "Every **process** contains complementary opposites, herein including **energetic** polarities, two-valued **information** and **structural symmetries**. Rise and fall, positive and negative, woman and man, right and left, **cooperation** and struggle, union and separation, **similarity** and **difference**, **symmetry** and **asymmetry**, necessarily coexist. In Heraclitus' magnificent

words, there is harmony in strife and strife in harmony. In contrast, logic postulates the absolute separation of opposites, a premise that leads to black and white thinking" (1994).

H. SABELLI also states: "The term opposition refers to both **synergetic** and **antagonistic interactions**. This apparent **ambiguity** of **language** reflects the fundamental fact that **synergetic interactions** and **antagonistic** ones are closely associated" (1991, p.2).

2365

OPTIMALITY (Sub-)²⁾

Premature **stabilization** of a solution prescribed by a search **algorithm**.

Sub-optimality can be prevented by the use of a **genetic algorithm**, which allows **self-learning processes** in constructed **machines**, or so-called "natural" ones.

2366

OPTIMIZATION²⁾

The search for the best possible way to reach the best possible **state** of a system.

The global optimization of a complex system is a permanently renewed transaction between stable or changing **constraints** bearing upon different **functions**, all needed for the **survival** of the system. In S. KAUFFMAN words: "In such optimization searches, many **parts** and **processes** must become coordinated to achieve some measure of overall success, but conflicting "**design constraints**" limit the results achieved" (1993, p.33).

2367

OPTIMIZATION (Sub)^{2) - 4)}

"The attainment of some kind of **optimum** in part of the system (which) precludes the attainment of an **optimum** for the **whole**" (K. BOULDING, 1972, p.84).

K. BOULDING states that this problem "which emerges out of economics... has a highly general significance" (ibid).

It arises, in human **organizations**, out of the inadequate – and in some cases downright non-sensical – use of technical tools applied to inadequate ends.

From another angle, K. BOULDING adds: "Many of the failures of **organizations**, for instance, are a result of suboptimization, which could be defined as the best way of doing something which should not be done at all, or more generally, finding the best way of doing something in particular without taking account of the **costs** which this solution imposes on other segments of the system" (ibid).

Suboptimization is a very general and dangerous result of hyperspecialization, as most **specialists** merely see as their duty managing and resolving as best as possible their own small segment of a global **situation** they consider to be outside their commitment... if even they are conscious of its existence.

2368

OPTIMIZATION THEORY²⁾

"A mathematical technique for determining the most profitable or least disadvantageous **choice** out of a **set** of alternatives" (K. KRIPPENDORFF, 1986, p.55)

This author states: "Typically the **set** of alternatives is restricted by several **constraints** on the values of a number of **variables** and an **objective function** locates the optimum in the remaining **set**" (ibid).

This is a technique used in **Operations research** and **Systems Analysis**. It should be observed:

1) That the definition of the **constraints** is outside the scope of the technique, as they are either discovered or prescribed by the **decision maker** (soundly or not). **Constraints** discovery is a typical systemic topic.

2) That optimization of a **process** or a **function** is different from the global optimization of a system, as for example an enterprise, and that **trade offs** are inevitable between **optima** defined for various **functions** or **processes**. **Maximization** of one of these frequently means sub-optimization of another or various other ones.

3) The technique in itself is "blind" to these global aspects of optimization. It is a good servant, but a suspicious master.

2369

OPTIMIZER²⁾

A **controller** able to seek by appropriate search the best possible maximum.

Such a **controller** must be endowed with a sufficient **memory** capacity in order to store the progressive results of its search, and with an **iterative refinement algorithm**, if it is not to remain trapped in a **sub-optimal situation**. (G. PASK, 1961, p.65).

2370

OPTIMUM^{1) - 2)}

The best possible condition for a system.

This very simple definition occults quite difficult **problems**. An optimum is generally **defined** by some **decider** in relation to some partial view of the system, corresponding to the aims sought by some **subsystem**. Optima are even frequently confused with maxima in specific **outputs** of the system. Maxima in turn, frequently can be sustained only for quite a

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

short **time**, until some basic **resource** of the system becomes depleted. (This **resource** may even be the permanence of **sinks** able to absorb constantly the products of the system).

The basic optimal condition of a system should guarantee it an adequate **stability margin**. In other words, specific **controls** should be correctly interconnected and interacting in order to allow the system *as a whole* to maintain its **dynamic stability**.

For example, production and consumption can be maintained more or less close to an optimum if their necessary **interdependence** is recognized. And both can be maintained stable at **long term** only if their **interdependence** with environmental conditions is recognized and respected.

2371

OPTIMUM (Dynamic)¹⁾²⁾

In a **growth process**, the moment at which the growth coefficient reaches its maximum. (C. GINI, 1952, p. 18)

C. GINI, an Italian demographer, used the concept in the study of **populations growth**, specially as related to the logistic **growth model** introduced by P. VERHULST (1838)

Dynamic optimum is a fleeting moment, after which growth starts to loose momentum, due generally to **negative feedbacks** from the **environment** of the system. Such feedbacks are in fact a **response** of the environment to the pressure that the system exerts on it, as for example an excessive use of non-renewable (or even renewable) **resources**, or the environment saturation, as a receiver of the **outputs** of the system. This can be for instance market over-saturation due to excessive production, or poisoning of the environment by unassimilable **waste**.

The question as if a dynamic optimum could be improved, by which means, and at which costs, remains open.

→ **Growth (Logistic); Logistic equation**

2372

OPTIMUM (Local)²⁾

The best **value** for a **function** in an **adaptive system** at some specific **time**.

This is however not necessarily the best possible value in its whole **range**.

If no provision is made in the genetic adaptive plan of the system in order to avoid blockage at such a value, the best possible **adaptation value** may be missed

2373

OPTION^{2) - 4)}

"Any possible **action** that might assist in resolving an **issue**" (J. WARFIELD, pers. comm.)

J. WARFIELD introduces the concept in his **Interactive Management methodology**.

The first and most important stage in **design** is the generation of options. Systemics opens the way to a wider field of options, as it broadens the field of inquiry and tries to avoid **underconceptualization**.

After generation, the options must be selected according to defined **criteria** and categorized. This is done by the **group** in charge of the **design**.

→ ("Nominal Group Technique" and "Interpretive Structural Modeling")

In view of the more or less unpredictable **changes** that the system can undergo, options should be maintained open as long as possible without risk for the system itself.

2374

ORBIT²⁾

The representation in the **phases space** of a **continuous** or **discontinuous trajectory**.

Orbits may be asymptotic, **periodic**, quasi periodic, non periodic or transitory (E. LORENZ, 1995, p. 216)).

→ **Phases portrait; Phases transition**

2375

ORDER^{1) - 2)}

The set of possible **interrelations (synchronic and diachronic)** among **elements**, arranged in a collection or in a system.

According to E. LASZLO: "Order in a system refers to the **invariance** that underlies its **transformations of state**, and by means of which the system's **structure** can be identified" (1974, p.210).

However "these relations... can undergo **transformations**" (Ibid). An hydrogen atom in a water molecule can be again separated, and enter in other combinations. However, through fusion, it disappears, becoming partly an **element** of an helium atom, "minus a radiated surplus of **energy**" (Ibid). The concept of order also becomes more and more elusive at higher degrees of **complexity**.

The concept of order includes **structures, functions** and, or **processes**.

At least three different types of order may be distinguished:

1°- **Algorithmic order**

The complete **set** of possible **interrelations** is precisely **prescribed** in a **set** of **invariable** instructions. Generally the sequential order of succession of the various but exclusively possible **states** is also prescribed.

2°- **Statistical order**

The **set** of possible **interrelations** becomes slowly revealed by a sufficient number of **observations** or experiments.

The sequential order of the possible **states** is frequently indeterminated (**Markov chains, Chaos**).

If an **algorithm** can be extracted from the statistics, its predictive value remains always doubtful: Averages are never totally free of atypical **fluctuations**.

3°- **Innovative order**

This is the so-called order (or **complexity**) from **noise**. It is proper of **self-organizing** systems who enhance their **variety** by using part of their internal **redundancy** to give significance to **noise** coming from their **environment**.

The study of increase, conservation or destruction of order are considered among others by **synergetics, thermodynamics** and **autonomy** theory under its various guises.

2376

ORDER and ENTROPY^{1) - 2)}

K.D. BAILEY comments: "a high degree of order indicates a system which has a low degree of **entropy**, and high degrees of **energy, information** and **negentropy**. Conversely, a system showing a low degree of **integration** has high **entropy**, with low **information, energy** and **negentropy**. We have specifically excluded the terms "**complexity**" and "**organizational complexity**" as they have not been adequately defined in the literature" (1987, p.92).

However, highly **dynamic systems** produce more **entropy** than the others, thanks to the absorbed **energy**, that they **dissipate** to order themselves. But, while they conserve or increase the acquired order, they export more **entropy** towards the **environment**. This is why some authors say – creating some confusion – that **entropy** grows with order. It should be said that order may grow *locally* only if **entropy** grows *globally*, as the ordering system produces more **entropy** but exports it toward the **environment**.

See: **Maxwell's Demon Paradox**.

2377

ORDER and ENVIRONMENT^{1) - 2) - 4)}

Order can increase within a system only if it is able to convey an increased **flow** of **entropy** into its **environment**. This implies that the **environment** must be **colder** than the system. R. FIVAZ puts it as follows: "... the **second principle** is preserved because the **environment** receives the latent heat flowing from the ordering system; as the **environment** is colder, its disordering is numerically larger so that the total **entropy** is indeed increased (1991, p. 22).

This is the ultimate relational problem between high **energy** degrading human systems and the global warming of the planet as the global **ecosystem**.

2378

ORDER and RANDOMNESS^{1) - 2) - 3)}

The relation between order and **randomness** remains still a vexing problem.

While a **complex system** needs strong **constraints** to maintain its **coherence**, these **constraints** reduce its adaptive potential and do not allow it to be more than a **link** in the chain of **evolution**. On the other hand, absolute randomness would preclude any order at all. Our conceptual opposition between order and **randomness** seems to be one more of these more or less artificial mental **dichotomies**.

When numerous **elements** of one kind become connected as in a **population**, or even in a **composite system** at its **critical state**, order seems to spring out from **randomness** at the so-called **edge of chaos** (self-organized **criticality**), probably because some **rules of behavior** emerge and stabilize. The cause or condition seems to be, for the **population** or **composite system**, to receive recurrent **inputs of energy**.

2379

ORDER (Degrees of)^{2) - 3)}

According to D. BOHM and F.D. PEAT, order is **embedding**, or **enfolding**, or **implicite** (1987, p.121 - 129).

These authors hypothesize "orders of infinite degree... which contain a very rich but little explored domain". They contend that: "Within this domain are to be found whole ranges of subtle and complex orders, some of infinite degree, which contain **embedded** within them many orders of lower degree. This **hierarchical nesting** of these suborders forms a greater order of its own" (Ibid, p.129).

These somewhat speculative ideas are at least in consonance with:

- 1/ - WEIERSTRASS **renormalization** equation
- 2/ - MANDELBROT's **fractals**
- 3/ - MATURANA and VARELA's **recursivity**

They moreover seem to lurk somehow in the human **brain**, as shown by the existence of the Russian **matrioshka**, the Japanese **kokeshi**, and some of **ESCHER's** engravings.

In the same vein, J. BRIGGS and F.D. PEAT observe that simple and regular order is exceptional in nature... The real nature's **archetypes** seem to be nearer to RUELLE's **strange attractors** and MANDELBROT's **fractals** than to Platonic solids (1991, French translation, p.110).

2380

ORDER FROM NOISE PRINCIPLE^{1) - 2)}

E. MORIN writes: "SCHRÖDINGER, in "What is Life?" stated that ordered **events** could be produced out of two basic principles, the first one "order from order" (**algorithmic**), the second "order from **disorder**" (statistical), from which two types of laws are derived, dynamic laws and statistical ones. Von FOERSTER, in 1959, advanced a third principle, which cannot be confused with the first ones, even if it depends on them: "Order from **noise**" (von FOERSTER

1960, p.31-50). It is a selective principle, according to which **noise-events** contribute to increase order in **complex systems**...

"Von Foerster says that "self organizing systems do not feed only in order, they find also **noise** in their menu." (1960) This Foersterian principle is different from SCHRÖDINGER's **disorder**, which is, *statistically*, order. But the Foersterian principle, as well emphasized by G. GÜNTHER (1962), establishes the synthesis: the "Aufhebung" (overtaking) of order-from-order and of order-from-**disorder** is mechanistic, "order-from-**disorder** is regularity, order-from-**noise** is novelty, or **creativity**" (MORIN, 1972, p.185).

This notion, however, should be received with caution.

R. VALLÉE writes: "... one should not forget that, when **noise** generates order, it is because it has been introduced in a structure otherwise (and already previously) ordered : magnets shaken in a box in von FOERSTER's example, or more simply wheat ears creeping upward in a sleeve under the influence of erratic movements. In von FOERSTER's example, order exist within the highly structured magnetic **interactions** among the magnets; in the case of the ears it surges from their very **dissymmetric structure**. **Noise** does not create order, but it is an excellent *structure displayer*. If order can be thus generated by **noise**, it is by means of an already existing **structure**, possibly not very evident, or under the influence of **constraints**, at times quite unobtrusive. **Noise**, nonetheless, plays a very important role as a **trigger** for the **emergence** of order in what is called *self-organization* or *autopoiesis* of a system"(1990, p.55).

Mac KAY states this in a different, but equivalent manner: "In fact, the badly phrased question: "Is **noise** information?" exemplifies well the need for *semantic hygiene* in the field. The question is incomplete. If translated "Has **noise** selective power?" it invites the immediate rejoinder "On what ensemble?" To specify the ensemble then removes all the **ambiguity** and obviates empty debate" (1969, p.134).

Finally, it seems that the principle of order from **noise** may mainly explain the increase of order which results of the fusion or synthesis of similar or complementary **elements** in an *associative process* which leads to the **emergence** of entities of a superior order of **complexity**. It could be the most basic motor of **evolution**.

2381

ORDER FROM ORDER Principle²⁾

E. SCHRÖDINGER, in his famed work "What is Life?" (1945) established the principle that order (in **living systems**) is somehow transmittable. He stated that "... the final approach to **equilibrium** is very slow. It could take anything between hours, years, centuries". He explained this by the way **living systems** "feed on **nega-**

tive entropy", i.e. maintain their **organization** "by extracting "order" from their **environment**". He describes this "order" as "**entropy**, taken with the negative sign,... itself a measure of order".

This so-called **negentropy** was a **source** of controversy for many years, until it became clear that it simply measures the **level of complexity** (order) in **complex systems**. The final connection with **thermodynamics** is through the creation of order by **dissipative structuration** of **energy** in **far- from- equilibrium** systems submitted to giant **fluctuations**, precisely because of very high **energy inputs**. (BÉ-NARD's **instability**; PRIGOGINE's **thermodynamics** of **far-away from equilibrium** systems).

As proposed by LOTKA with his "**world engine**" model, the **energy** provided by the sun is *slowly* degraded through a "ladder" of systems. Endly, increases of order in some systems must be paid by a correspondingly higher decrease of order in their **environment**.

SCHRÖDINGER's principle has been extended by H.von FOERSTER, precisely in relation to his principle of "**order from noise**". (see above, for critical appraisals)

Its relations with DAWKINS "Selfish Gene" should also be explored. What is transmitted from system to system is not merely order, but better **historical structural** and **functional** order.

→ **Operon**

2382

ORDER (Generative)^{2) - 3)}

"A deeper and more inward order out of which the manifest **form** of things can emerge creatively" (D. BOHM & F. DAVID PEAT, 1987, p. 151).

This is a generalization of the "implicate order" concept formerly introduced by D. BOHM himself: "...a particular kind of generative order that has been most fully worked out in physics" (Ibid).

However, BOHM and PEAT suggest that: "... such a generative order goes far beyond the quantum theory, and is a key feature of the general notion of order that is relevant to understand **creativity** in all areas of life" (3p. 195).

Generative order seems to be in BOHM's idea a kind of universal and global **limit to randomness**. It remains present, for instance, in **deterministic chaos**.

→ **random**

According to BOHM and PEAT, the **concept** is also useful in the study of **social systems**: "The breakdown in the generative order of society is more than mere **decay**... Rather, the rigidity in the generative order constitutes an extremely pervasive and far-reaching blockage of

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

free play of the mind, and this makes for the constant spread of false play and prevents **creativity** that could adequately meet this **situation**" (p.209).

Values could be the form taken by generative order in human societies. But we would need a clear explanation for its breakdown.

2383

ORDER (Generative) and EVOLUTION¹⁾

D. BOHM and F.D. PEAT discuss the **meaning** or generative order in relation to **evolution**. They write: "While the current neo-Darwinian theory is valid in its proper domain, it represents an **abstraction** from a much larger implicate and generative order, and its main significance is to be found in its relationship to this latter order" (1987, p.201).

This is an interesting hypothesis: Nothing is possible outside the basic generative order (for example biological life – at least of the kind we know – would be impossible in a **universe** wherein macromolecules could not be formed). In this sense, generative order is **autopoietic**. However, within the very wide reach of this order, creative **variation** is possible and the **phase space** of **living systems** can expand and finely divide. It ensues that **evolution**, while channeled, is and will necessarily be, a unfinished historic **process**.

Is this something that needs to be proved in the classical sense of scientific "proof"?

2384

ORDER (Implicate)¹⁾³⁾

The hypothesis according to which there is a deeper **level** of order in the **universe** that we can only glimpse in a fleeting way through local and momentaneous **effects**.

The hypothesis has been introduced by D. BOHM (1980) as an **interpretation** of **events** at the quantum level.

Any observed **phenomenon** should be viewed as a "explicate", unpermanent manifestation of the universal implicate order. All **forms** and movements -corresponding to our **perceptions**- would be only transient **fluctuations** of the basic cosmic "fabric" or "**whole**" as a continuum of **energy** whatever this could be

As in many other cases, the explanation generates new question marks. Implicate order could even conceivably signal the end of the road for scientific inquiry

In effect, implicate order carries obvious philosophical undertones and reminds of some pronouncements of hindu philosophy. G. ROUVILLOIS writes the following about SHRI AUROBINDO's **space-time** concept: "The original statute is that of a non-temporal and non-spatial **Reality**. Space and time would be the same

Reality extending herself to obtain the unfolding of what was contained in her. Space and time are the names that we bestow on this self-extension of the one Reality.

"The starting point of AUROBINDO's analysis is the opposition between the unmanifested and manifestation. In a manner, one may say that manifestation belong to a lower **order** of reality than the unmanifested...

"The non-manifest is the non-temporal, the absolutely eternal, an absolute being by itself, on which manifestation and its limitations can give only a limited and deceitful **indication**" (1998, p. 79)

The parallelism with BOHM's view is striking. ROUVILLOIS asks himself: "Is space -time a conceptual **frame**, or a mirror of **brain symmetries**?"

It seems that we cannot finally escape from a lingering doubt about the real **meaning** of "Reality" (with or without a majuscule) and our perceptive **awareness** as the source of "manifestation".

→ **Manifest versus hidden; Ontological skepticism; Present (the everlasting); Quantum Hologram; Quantum vacuum**

2385

ORDER (Local)²⁾

The existence in some region of a system of more strongly interacting **elements**.

Local order corresponds partly to the concept of **frozen components**, or "functionally isolated islands of **elements**" (St. KAUFFMAN, 1993, p.205). It implies a polar relation between global **stability** and **instability** and also a **trade-off** between **coherence** and **adaptability**. Too many **frozen components** tend to reduce **adaptability**.

Local order results of the superposition of some more specific order within a reduced **region**, upon a more general order.

WEIERSTRASS' **renormalization** or MANDELROT's **fractalization** produce local order, which seems to be generally **similar** to the higher order.

2386

ORDER (Optimal)¹⁾

That order which secures for the system the best conditions (in order of importance) of **survival** and **efficiency**, at the lowest **cost**.

Trade-offs between these conditions are possible, but will inevitably lead to a sub-optimal order.

→ **Optimality (Sub-); Optimum; Optimization**

2387

ORDER OR ORGANIZATION?¹⁾

According to J. WICKEN (quoted by R.N. ADAMS): "Biological **structures** are not 'ordered' in the sense prescribed by **information**

theory; they are 'organized' ...whereas ordered systems are generated according to simple **algorithms** and therefore lack **complexity**, organized systems must be assembled **element** by **element** according to an external 'wiring **diagram**' with high informational **context**" (1979, p.353-61).

The "wiring diagram" seems to be a somewhat dubious **metaphor**. The "diagram" is nowhere to be found in living beings or societies, which start at most with **positional values**, and resulting polarizations.

K. DENBIGH'S formulation (also quoted by ADAMS) seems clearer and less inspired from a **mechanicist metaphor**: "... a crystal is more "orderly" than a cell since in the former the atoms and molecules stand in a fixed **relationship** to each other; they repeat themselves at fixed distances... The cell, however, is more organized. DENBIGH does not attempt a final definition of **organization** but does suggest two requirements. One is that of "**complexity**": an organized system necessarily consists of **parts** and **subparts** and these are interconnected" (1988, p.73) (One could say that the **parts** are very **heterogeneous**, as they result from an intense **process of differentiation**).

"Secondly, a further necessary condition for a system to be said organized depends on the notion of **function**... One cannot speak about something being organized without at once raising the **issue**, what it is organized for?" (DENBIGH, 1975, p.85)

In synthesis, order should be considered repetitive, while **organization** is **heterogeneous**, complementary and **hierarchical**.

2388

ORDER PARAMETER^{1) - 2)}

"Global, **macrolevel** parameter which describes the **structures** established in a system" (R. FIVAZ, 1991, p.32).

The order parameter was introduced in the 1940s by the Russian physicist Lev LANDAU.

According to K.DE GREENE's interpretation of H. HAKEN: "The order parameter represents the **macroscopic structure** or **field** emergent out of **interactions** at the more **microscopic level**. The **correlation length** ... is an order parameter. In **phase transitions** order parameters can increase discontinuously from zero (first-order **transition**) in the new **phase**, or they can increase continuously (second-order **transition**). The **emergence** of order is an example of **symmetry breaking**... an important concept in **field theories**...

"The order parameter is a **macroscopic** collective **field**, emergent at **critical points** out of myriad **interactions** at the **microlevel**. (It) expresses stochastic generation of the new (**structural change**) and **deterministic maintenance** of the now established (**structural constancy**). The **emergence** of the order pa-

parameter represents a great loss of **degrees of freedom** at the **microlevel**... (which) now becomes **slaved** to the order parameter" (1994, p.14).

→ **Phase locking**

2389

ORDER PARAMETER APPROACH²⁾ – 3)

The selection of some specific viewpoint or **level** for the study of a system.

R. SERRA and G. ZANARINI state: "The key concept in the 'order parameter approach' is that there are privileged viewpoints for studying **complex systems**. There are alternative **descriptions** which render some aspects comprehensible, while others are useless or frustrating. We can speak of 'comprehensibility windows', i.e. of **description levels** which allow a reasonable treatment of the system, while capturing its essential features" (1987, p.112).

As an example, the authors use **Brownian motion**, that can be viewed at the microscopic, mesoscopic or macroscopic **level**. This approach can be applied to cultural as well as natural systems.

2390

ORDER PRINCIPLE (BOLTZMANN's)²⁾ – 3)

"Systems, in the course of **time**, tend to the most probable **state**, as given by the number of corresponding complexions"

I. PRIGOGINE et al write: "This leads to an increase of the **entropy** *S*, for **isolated systems** or a decrease of the free **energy**, *F*, in **closed systems**" (1975, p.17).

It sounds more as a "Disordering Principle"!

2391

ORDER (Random)²⁾ – 3)

This somewhat paradoxical notion is explained in the following way by D. BOHM and F.D. PEAT: "... a random order can be defined as a special case of a **chaotic** order. It has the following characteristics:

1. It is of infinite degree
2. It has no significant **correlations** or stretches of suborder of low degree
3. It has a fairly constant average **behavior** and tends to vary within a limited **domain**. This **domain** remains more or less constant, or else it changes slowly" (1987, p.127).

The authors state: "This definition of random order accounts well for the distribution of shots from a fixed gun".

However, they recognize that: "... if the **context** is extended, then each shot becomes more nearly predictable. For example, if the wind velocity is measured, or if **variations** in the gun emplacement are observed, then more **information** is available to determine the new **con-**

text and individual **variations** can be calculated. This emphasizes again that the notion of **randomness** is inherently **context-dependent**" (ibid.).

In synthesis, in conformity with **chaos theory**, there is no absolute **randomness** (i.e. **randomness** of infinite degree), nor absolutely predictable order.

2392

ORDER through FIT¹⁾ – 4)

G. BROEKSTRA describes this managerial concept as based on "...the notion of fit or internal **consistency** between core organizational **variables**" and signals that: "Thus, from the beginning the rationality of **equilibrium** became associated (with it). It was understood that **fluctuations** in the form of misfits, **inconsistencies**, paradoxes, or contradictions, had to be dampened or suppressed. In this way, the fit **paradigm** became a unitary approach driving an **organization** towards a particular **stable attractor state (configuration)**. However, although a tight fit may lead temporarily to excellence... paradoxically, in the long run, fit may lead to failure" (1993, p.76).

Maintaining **stability** at any **cost** may not be the correct response when some internal or external condition basic for such a "**stable attractor**" is not anymore guaranteed.

BROEKSTRA explains that in this case: "... a new way of thinking about organizing is called for, one that encompasses this paradox. The old fit perspective does not disappear, but is absorbed into a more comprehensive theory" (p.77).

BROEKSTRA proceeds in his paper to the elaboration of such a theory based on the **chaos** hypothesis of **change**.

2393

ORDER THROUGH FLUCTUATIONS²⁾ – 4)

In PRIGOGINE's words, a "new order principle" may appear "that corresponds essentially to an **amplification** of fluctuations and to their ultimate **stabilization** by the **flow of matter and energy** from the surroundings. He calls this principle "order through fluctuations". An additional important element should be pointed out: "The shaping of a fluctuation of a given type is *fundamentally a stochastic process*. The **response** of the system to this fluctuation is a **deterministic process**, obeying the **macroscopic laws** as long as the system can damp the fluctuations. Now, in the **domain** of formation of a new **structure**, fluctuations are amplified and drive the average values to the new **regime**. Thus, in this **region** the **macroscopic description** in terms of averages breaks down and the evolution acquires an essentially statistical character.

"We have then a picture of a system evolving through **instabilities**: In the **neighbourhood** of a **stable** regime, **evolution** is essentially **deterministic** in the sense that the small fluctuations arising continuously are **damped**. But near a **transition threshold** the **evolution** becomes a **stochastic process** in the sense that the final **state** will depend on the probability of creating a fluctuation of a given type. Of course, once this probability is appreciable, the system will eventually reach a unique (apart from small fluctuations) **stable state**, once the **boundary conditions** are specified. This **state** will then be the starting point for further **evolution**" (1973, p.587-8).

E. JANTSCH writes: "...PRIGOGINE shows for the physical **domain** that partially **open systems** in a **state** of sufficient **nonequilibrium** (so-called **dissipative structures**) try to maintain their capability for **energy** exchange with the **environment** by switching to a new **dynamic regime** whenever **entropy** production becomes stifled in the old **regime**. This is the principle of 'order through fluctuation' which reverses some of the dynamic characteristics holding for **closed systems** and **systems near equilibrium**" (1976, p. 38-9).

Let us remember that in this work we prefer to use the term '**isolated**' instead of '**closed**' for abstract **models** of systems to which the **2nd Law** is applicable without any restriction.

JANTSCH adds: "In particular, order may increase (whereas in **closed** or **near-equilibrium systems**, according to the **second law of thermodynamics**, it can only change toward greater **disorder**), and the response to **fluctuations** (which may themselves be **random**) is the less **random** the more **degrees of freedom** the system has" (p.39).

This is probably the basic reason for some very fundamental effects we are presently witnessing in contemporaneous societies, as:

- an **exponential growth** of **energy** consumption
- more and more violent economic, ecological and social **fluctuations**
- the appearance of evermore complex organizational **structures** (as for example numerous megalopolis)
- the enormous increase in the production of **waste** of all kinds.

Remains to be seen if a more global planetary system of higher **complexity** will emerge.

An intriguing relation with GRASSÉ's **stigmergy**, is considered by PRIGOGINE, who, in relation to GRASSÉ's concept considers that any originally **random fluctuation** may become the **original nucleus** for **dissipative structuration**. This provides a connection with the **model of order from noise**.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

2394

ORDINALITY²⁾

The logical **level** of a certain **order** of **complexity**.

Ordinality is a basic **concept** of RUSSELL and WHITEHEAD's **Theory of Logical Types**, which solved the paradoxes resulting precisely of the mixing of different logical **levels**.

2395

ORGAN²⁾

The **set** of "all the **components** which carry out the **processes** of a given **subsystem** of an **organism**" (J.G. MILLER, 1978, p.315).

The organ is the second **level of complexity** in MILLER's **taxonomy of living systems**. It is made of **cells** and has a defined structural and functional role in an **organism**.

MILLER comments: "This is like one common **meaning** of organ, "a part of the body having a special **function**" and different from another current usage, "a more or less independent portion of the body having a tissue framework, and a special blood, lymph and nerve supply in addition to its characteristic essential **cells**" (Ibid).

2396

ORGANICISM³⁾

An epistemological attitude which tends to consider the **organism** as a legitimate **level of understanding**, as opposed to a **reductionist (mechanistic)** attitude which aims to explain the properties of the **whole** through the ones of its **elements**". (E. SCHWARZ, 1993, p. 10)

A quite different definition, of a neat metaphorical nature is also given by SCHWARZ: "social philosophy of the 19th C. according to which the social body works like an **organism**, i.e. as a coherent whole, whose every **part** carries out some **function** needed to the whole" (Ibid)

This last view is as old as the Roman parable about "the members and the stomach" and, while basically acceptable to begin with, is surely also a **mechanistic** and excessively simplistic view of societies (even the lower organisms one)

In short, organicism is in effect an "epistemological attitude" that should be scrutinized closely when applied.

However, organicism led biology out of its vitalist dead end and is also at the roots of systemics

Organicism appeared at the beginning of the 20th Century in the field of biology., (J.H. WOODGER and L.von BERTALANFFY), as a reaction against **mechanicism**, as well as **vitalism**.

Organicism, which is interested in the global properties of **organisms**, as supplementary to the properties of their **parts**, became through von BERTALANFFY's influence, one of the original roots of **systemics**.

2397

ORGANICISM (BAHM)³⁾

A. BAHM has proposed a general concept of organicism, i.e. not limited to biology, in the following terms:

"... it centers about a concept of "organic unity"... organicism incorporates emergentistic ideas about **holons** as loci of integrative tendencies conducive to the **emergence** and maintenance of larger **wholes** and higher **levels of organization**... It holds that sometimes the tendencies in **parts** to unite in a larger **whole** are stronger, and sometimes the tendencies of a **whole** to unite its **parts** are stronger. When these two kinds of tendencies cooperate, **integration** is facilitated; when they compete, **integration** may be retarded...

"Organicism concedes to **structuralism** that when organicism attributes organic **wholeness** variably to all existing system, the universal presence of such organic **wholeness** may be regarded as a structural **invariant**" (1984, p.207).

2398

ORGANIGRAM²⁾

The general plan of an **organization**.

This would be a neologism in English, as the word is in fact a French one (also adapted in Spanish).

An organigram is generally represented as a static chart, or **graph** representing the **structure** (generally a **tree**) or as a **flow chart** (when representing the **set of operations**).

2399

ORGANISM^{2) - 5)}

A coherent **set** of structured biological **elements** able to fulfill **processes** and **functions**.

This is the third **level of complexity** in J.G. MILLER's **taxonomy of living systems**. Organisms are made of interconnected **elements** ordered in **structures** (like **organs**) and able to carry out interdependent **processes**, producing a global behavior. MILLER also classifies as organisms **colonial living forms** and multicellular **structures**, as for example slime molds, when in their aggregated state. (See "**dictyostelium discoideum**").

N. RASHEVSKY gives a more formal definition: "...a system which satisfies a prescribed **set** of n-ary **relations** or, in other words, which is described by a **set** of n-placed predicates that are characterized by specified properties".

This author adds a caveat: "The **choice** of the system of such predicates still remains, however, to a large extent, arbitrary" (1967, p.21).

RASHEVSKY states: "A social organism is a **set** of individuals... A multicellular biological organism is a **set** of **cells** and... a unicellular organism may be considered as a **set** of genes" (Ibid).

An organism may thus be a **living system**, or a system of **living systems**.

G. PASK states: "... when we speak of an organism, rather than the chemicals it is made from, we do not mean something *described by* a **control system**. An organism *is* a **control system** with its own **survival** as its **objective**. The basic **homeostasis** is to preserve itself as an individual... To survive in changeable surroundings an organism must be an **adaptive control system**" (1961a, p.72).

This concept, first proposed in 1961, is closely related to **autopoiesis** and **autonomy**, as can be seen in the following quotation from PASK: "The overall **homeostasis**, preserving the organism, can be expressed as the conjoint action of many **homeostatic** systems, each preserving a **structure** or condition needed for the functioning of the others" (p.73).

It is now commonly admitted, as stated by V. CSANYI, that an organism "... is a more or less autonomous **network** of **components** and **component** producing **processes** which is replicating in **time**... As a unity it is also a **component** of higher **organizational levels**, like **ecosystems** or the whole **biosphere**" (1993, p.264).

This view is close to the **organizational closure concept** as well as to **connectionism**.

→ **Auto-genetic system precursor**

2400

ORGANISMIC³⁾

Character of any **model** based on an **analogy** with living **organisms**.

"Organismic is used to describe a **relationship** between individuals such as their **autonomy** and **identity** are in part absorbed or entrained by the **interactions** which form a greater **whole** of which they are "**components**" insofar as the communicative **sets** are concerned" (F. ROBB, 1990, p.139).

ROBB applies the **concept** to human **organization**, but its origin is – as well known – biological. Thus, more generally we may replace "individuals" by "constitutive **elements**".

2401

ORGANISMIC ANALOGY⁴⁾

In a paper presented at the Annual Meeting of the Association for Politics and the Life Sciences (Montreal, Canada, Aug. 2002) Peter CORNING writes:

"The so-called "organismic analogy" which has graced social and political theory (off and on) ever since Plato, has reemerged in evolutionary biology in recent years as a way of characterizing key properties of social **organization** in the natural world although the preferred moniker these days is Herb SPENCER's term "**superorganism**". Biologists often give credit to one of their own, William Morton WHEELER, but Wheeler's writings appeared several decades later. As Spencer himself argued, the organismic analogy is justified by the existence of common functional properties at "higher" **levels** of biological organization, including especially "functional **differentiation**" and "**integration**" with respect to the pursuit of overarching, "collective" **goals** or objectives; there is a functional commonality between **organisms** and superorganisms. But more important, superorganisms may also constitute a distinct unit of **selection** (and adaptive **change**) in the evolutionary process. In accordance with the so-called "Synergism Hypothesis", the combined functional **effects** that are produced by social "**wholes**" are the primary causal agency underlying the evolution of **cooperation** and **complexity** in nature. It is the **synergies** (the economic payoffs), broadly speaking) that are the drivers for evolutionary **complexification**... (A number of illustrations will be provided, including bacterial colonies, social insects, symbiotic partnerships and social mammals). Without exception, however, superorganisms are also dependent upon **cybernetic (communications and control) processes**, or **governance**. Accordingly, human superorganisms (and their "political systems") are not sui generis but are variations on a major evolutionary theme... Indeed, it is likely that social organization played a key part in human evolution, and in the rise of civilization. (the accumulating evidence will be briefly reviewed in this paper.) A modern human society represents an elaboration upon an ancient hominid **survival strategy**. It is, quintessentially, a "collective survival enterprise." This perspective casts a different light on the ongoing process of cultural evolution and the much-debated prospects for global governance, or political "devolution" or both. Paradoxical as it may seem, the current, dualistic trend toward both more and less inclusive superorganisms may continue as the economic and political topography and the functional needs for governance continue to evolve. Accordingly, a global superorganism may well be emerging even as traditional nation-states are devolving. The history of the European Union suggests that an explicit "vision" of a global superorganism can serve as an important motivator and catalyst for this process. However, this is only the beginning. To quote the distinguished 20th century evolutionary biologist,

Theodosius DOBZHANSKY: "The future is not vouchsafed by any law of nature, but it can be striven for."

→ **Co-evolution; Morphic field**

2402

ORGANISMIC BIOLOGY ¹⁾²⁾⁵⁾

A set of new concepts about the nature of living **organisms** that was introduced between 1920 and 1940 by a number of biologists as an alternative theory of life, as opposed to **reductionist mechanistic** concepts as well as **vitalists** ones

The basic tenet of organismic biology is that life cannot be understood without a general integrative view of the internal **organization** of the organism, i.e. the existence of **functional** and **structural interrelations** between its constitutive **elements**. Thus "the whole is more than the sum of its **parts**"

F. CAPRA writes: "Since these organizing relations are patterns of relationships immanent in the physical structure of the organism, organismic biologists assert that no separate, nonphysical entity is required for the understanding of life..."...the concept of organization has been refined to that of self-organization in contemporary theories of living systems" (196, p. 25)

→ **Autopoiesis**

2403

ORGANISMIC SET ^{2) - 4)}

"A mathematical entity that has properties common to both biological and social **organisms**" (N. RASHEVSKY, 1967, p.21).

RASHEVSKY, who introduced the concept, gives the following examples: "A social **organism** is a **set** of individuals who are the **elements** of the **set**. A multicellular biological **organism** is a **set** of **cells**; and... a unicellular **organism** may be considered as a **set** of genes..."

"Moreover, in all organismic sets, that is, in both biological and social **organisms**, the **elements** of the set replicate or multiply..."

And: "An organismic **set** of **order** *n* is a set whose **elements** are organismic **sets** of **order** *n - 1*".

RASHEVSKY finally claims that "The theory of organismic sets forms a sort of conceptual superstructure over biology and sociology" (p.21, 22, 27).

2404

ORGANIZATION ^{2) - 4)}

1) The **set** of actual or possible **interrelations** between the **components** of a system.

(or, for human organizations) "The entire **set** of **relationships** it has with itself and its **stakeholders**" (I.I. MITROFF and H.A. LINSTONE, 1993, p.142).

2) A system made of interconnected functional **elements** or **subsystems**, generally in various **hierarchical levels**.

H. Y. LERNER, quoted by J. ESPOSITO notes that: "The concept of organization is very difficult to define accurately, but from **intuition** it is clear that organized systems are far from being in "**thermodynamic equilibrium**". For instance, a gas consisting of molecules moving at **random** can be considered as having a zero degree of organization, whilst **organisms** capable of maintaining their existence and reproducing themselves have a high degree of organization" (1972, p.8).

J.L. ESPOSITO comments that, lacking **equilibrium**, organizations must necessarily engage in exchanges with a specific **environment**. He adds that: "In nature there may be nothing corresponding to a zero degree of organization, for an unconfined gas, like a frictionless surface, may remain only a theoretical ideal. From these remarks, then, it is clear that **closure**, **control** and **exchange** are necessary conceptions in any definition of organization" (1975, p.134).

And still: "An organization will be seen to constitute a balance between activator and inhibitor factors corresponding in general to the contrast between **negentropy/information-gain** and **entropy/information-loss**. In such a contrast can also be found the dual and biperspective nature of organization as both **object** and **process**" (p.135).

2405

ORGANIZATION (MILLER) ⁴⁾

"A system with multiechelon deciders whose **components** and **subsystems** may be subsidiary **organizations**, **groups** and (uncommonly) single persons" (Adapted from J.G. MILLER, 1978, p.595).

This is, in MILLER's **taxonomy of living systems**, the level that supersedes the **group**.

MILLER states: "Organizations are **subsystems**, **components**, or subcomponents of **societies**, sometimes more than of one **society** (p.595).

2406

ORGANIZATION: A descriptive language ¹⁾

J.L.R. CHANDLER proposes the following four descriptive concepts relative to the **behavior** of any degree of **organization**:

Closure: a **domain of discourse**, a **category**, a system, an **object**, unity

Conformation: the **components** of the closure of a system, the internal **patterns** of the system, the **relationships** among the **parts** of the system, a three dimensional depiction of the internal **description** of the system, a specific geometric and algebraic **description** of **components** of the system

Concatenation: binding **parts** together, linking changes in the conformation, changes in the internal **patterns** of a system, the specific **link-ages** between parts of the **whole**, **dynamic processes** of the system linking patterns to patterns

Cyclicity: a pattern of concatenations which sustain the system, the potential **cyclic walks** or **pathways** over the conformations of the system, the habitual **behavior** of the **closure**.

"These four concepts serve as the basis for a linguistic **description** of simple and complex material systems. In principle, each concept can be applied to the enumeration of each degree of **organization**..."

"These four terms are interdependent with each other and must be defined sequentially" (1998, p. 20)

This last comment explains why some of these definitions are not given separately in the Encyclopedia.

2407

ORGANIZATION as a pattern ²⁾

Organization may be understood as a **pattern** (in contrast to **random distribution of elements**):

- either in **space**, as a stable **structure**
- or in **time**, as a changing **structure**

E. MORIN proposes three different types of organization, understood as a **process** evolving in **time**:

- **Re-organization**, which expresses **diachronic transformation**;
- **Self-organization**, which corresponds to **closure** of the system by **recursion**, and **autonomy**;
- **Eco-organization**, which expresses the systems openness on its **environment** (after MORIN, 1990).

2408

ORGANIZATION as a process of progressive mechanization ¹⁾

According to L von BERTALANFFY: "At first, systems – biological, neurological, psychological or social – are governed by dynamic **interactions** of their **components**; later on, fixed arrangements and conditions of **constraints** are established which render the system and its **parts** more efficient, but also gradually diminish and eventually abolish its **equipotentiality**" (1956, p.5).

This reduction of the **degrees of liberty** of the relations among **components** leads to their grouping in a limited number of structural and functional **subsystems**, i.e. to the **heterogeneity** proper to **complex systems** and to the establishment of functional **algorithms**. These latter can be very rich, but are nevertheless quite limited when compared with the original potential of the system. It is thus apt to speak of mechanization.

2409

ORGANIZATION as a system ^{1) – 4)}

So many definitions have been given for "organization" in so many different senses that it seems convenient to qualify different **meanings**

C. ARGYRIS gave the following descriptive definition:

"An organization is a plurality of **parts**, each:

1. achieving specific **objective(s)**;
2. maintaining itself through interrelatedness with the other **parts**;
3. simultaneously adapting to the external **environment**, and;
4. maintaining thereby the interrelated **states** of the **parts**" (1959, p.124).

These characteristics are of course describing a "**whole**" or a "**system**".

According to W. BUCKLEY a "morphogenic" **model** of the organization would be useful to emphasize its progressive build up as it emerges from the **interaction** of the **elements** and the **flow** of **information** among them.

F. ROBB considers that: "Organizations are **social systems** purposely **designed** and constructed by men to achieve specific **goals** and to perform some explicitly defined **functions**. They are defined *initially* by their human **designers**, and, at least *in principle*, are **controllable** systems" (1993, p.3 – Italics by this compiler).

As human organizations imply a great **variety** of necessary, recommendable, merely tolerable or downright forbidden **interactions**, they are based on **rules** of conduct, either tacitly known and admitted, or legally stated and recognized by their members. Some of these **rules** are prescribing the **behavior** of the members within the organization, while others are directed at the **interactions** of the organization and its members with other systems, or the **environment** in general.

ROBB adds: "... at the **macroscopic level** the institution expends much more lifetime in sustaining itself. It does this by employing its **distinctions**, **values** and definitions in **communications**, by ritualizing the reiteration of its sacralised "**truths**", and by collecting anomalies and **ambiguities** arising from incoherent and inconsistent **conversations** and **actions** for redistribution as "**problems**" to be solved by further **conversations**" (p.4).

These views are synthesized by J.van GIGCH, according to whom "The organization is an **information** system which functions like an Intelligent **Artifact**" (1993, p.52).

Practically, organizations acquire promptly their own systemic logic and a degree of **autonomy** respect of their **designers**, become more or less unpredictable and even, sometimes, lead them to some unforeseen **situations**, as their **control** turns illusory. This implies that **design** must be a reiterative **process**.

2410

ORGANIZATION (Autopoietic) ^{1) – 2)}

"The **invariant** relations that hold between the **components** of a composite unity of a particular kind" (H. MATURANA, 1979, p.23).

The autopoietic form of organization is fundamentally different from the **allopoietic** one.

M. ZELNY resumes in the following way MATURANA and VARELA's work: "Autopoietic organization is realized as an **autonomous** and self maintaining unity through an independent **network** of **component-producing processes** such that the **components**, through their **interaction**, generate **recursively** the *same network* of **processes** which produced them. The product of an autopoietic organization is thus not different from the organization itself. A **cell** produces cell-forming molecules, an **organism** keeps renewing its defining **organs**, a social **group** "produces" **group**-maintaining individuals, etc. Such autopoietic systems are **organizationally closed** and structurally **state-determined**..." (M. ZELNY, 1977, p.13).

This means that the organization (or system) maintains its **identity**. However the system, while **organizationally closed**, is *not isolated*, because this being the case, its **survival** would be impossible, in accordance with the **2nd law of thermodynamics**.

Moreover, the autopoietic organization uses **inputs** from its **environment** to maintain itself, but also transform some of these **inputs** to produce specific **outputs**.

As stated by ZELNY, the **allopoietic mode** of organization is characterized by the fact that the system does not produce its own **components**, nor possesses the **processes** to produce them. "Thus, **allopoietic** systems are not perceived as "living" and are usually referred to as **mechanistic** or contrived systems... For example, spatially determined **structures**, like **crystals**, or macromolecular chains, **machines**, formal **hierarchies**, etc., are **allopoietic**" (Ibid).

2411

ORGANIZATION (Characteristics of) ²⁾

BERTALANFFY stated (1956) "Characteristics of organization, that of a living **organism** or a **society**, are notions like those of **wholeness**, **growth**, **differentiation**, **hierarchical order**, **dominance**, **control**, **competition** and so forth" (1956, p.7).

He noticed that: "Such notions do not appear in conventional physics" (while) "Systems theory is well capable of dealing with these matters" (Ibid).

He gave as examples of specific systemic theories those about biological **equilibria**, **cyclical fluctuations** and others introduced by

LOTKA, VOLTERRA, GAUSE and more authors and signaled their probable **isomorphy**, at least partial, with certain quantitative theories in economy.

2412

ORGANIZATION (Characteristics of a human)^{2) - 4)}

According to R. ACKOFF "The four essential characteristics of an organization can be briefly identified as its: a) **content**, b) **structure**, c) **communications**, and d) **decision-making (choice)** procedures" (1960, p.3).

It is this last point that identifies human organizations, as different from those defined by BERTALANFFY

ACKOFF states in a more detailed way:

"1. Some of its **components** are... human beings. Wires, poles, switchboards and telephones may constitute a **communication** system, but they do not constitute an organization...

"2. Responsibility for **choices** from the **set** of possible **acts** in any specific **situation** is divided among two or more individuals or **groups** of individuals... a) by **function** ... b) by **geography** ... c) by **time**....

"3. The functionally distinct subgroups are aware of each other's **behavior** either through **communication** or **observation**...

"4. The system has some **freedom of choice** of both **means** (courses of **action**) and **ends** (desired outcomes) (p.2).

How these characteristics show through in specific **parts** of an **organization** is described for example as follows by H. MINTZERG (1979) who identifies the following ones:

- the operating **core** where **tasks** are centred around the actual production of goods or services
- the strategic apex where top **management functions** are carried out
- the middle line which links the **strategic** apex to the operational **core**
- the technostructure where the **structure** and **processes** within the **organization** are planned, organized and re-organized
- the support staff which supports the functioning of the operational core"

2413

ORGANIZATION (Coherent)¹⁾⁴⁾⁵⁾

J. WARFIELD (pers. comm.) defines coherent organization in a most general way as "a virtual organization, furnishing a **context** in which **complexity** is very often located, and wherein it must usually be dealt with, if **resolution** of complexity is desired".

This is in fact a practical consequence- and should be a practical application- of ASHBY's **Law of Requisite Variety**

A frequent drama is that the implicit incoherence of a given organization becomes evident only when some unforeseen crisis or **disaster** emerges.

It is of course a result of what Warfield himself describes as **underconceptualization** in the minds of the managers of the organization.

It is in fact a **model** of **meta-organization** through which the different levels of an organization, or the **interrelations** between a number of different organizations can be described.

This should be in fact a practical application of ASHBY's **Law of Requisite Variety**

WARFIELD comments: "It is even possible that the inability of the individual to comprehend complexity, imprisoned by a constraining institutional setting, is responsible for what has been described as a "flight from science and reason". (P.R. GROSS et al.) and for ascendancy and popularity of management gurus"(J. MICKLETHWAIT & A. WOOLDRIDGE)

WARFIELD explains: "The coherent organization is a virtual organization with three organization levels. Any conventional organization can be thought of as a changing collection of such virtual organizations".

He distinguishes a Level 3, the producing level..."in which goods and services are produced". Most of the **population** of the organization belongs to this level. Level 1 is "the **strategic** level, the level in which broad **goals** are enunciated, where most of the authority lies, and where the **survival** and **growth** of the organization is pondered". It is in fact the "managers level".

"The intermediate level, Level 2, is the Mediating Level. At this level, the Level 3 activities and the Level 1 strategies are mediated.

In order for this **mediation** to be effective, people in the Mediating level (let us call them "middle managers") must be aware of what is happening at both the lower and the higher level"(pers.comm.). The level 2 people must convey the general vision elaborated by level 1 people to the producers at level 3.

They must also convey the practical realities faced by level 3 people to managers at level 1. All this is in fact a **feedback network** between levels.

2414

ORGANIZATION (Cost of)¹⁾

The **maintenance** cost of organizations in terms of needed **energy inputs**, grows accordingly to their **complexity**, i.e. to the number of the interconnecting pathways among their **components**, **elements** or **compartments**.

According to H.T. ODUM "... the potentialities for diversity are related to the **energy** budget in... square **functions**" (1983, p.216).

Moreover, A. UYEMOV links organization with disorganization: "the origin of disorganization is linked with the **growth** of organization in another system" (1975, p.95).

If so, **useless complexity**, i. e. the creation of non-functional links between **components**, should be avoided (as for example in **overburdening** bureaucraties, or **controls**).

2415

ORGANIZATION (Emergent levels of)^{1) - 2)}

More complex levels of organization do emerge by **structuring dissipation processes**, which appear in systems submitted to giant **fluctuations** that finally destroy their **steady state** and **dynamic stability**.

The **process** is however still somewhat enigmatic.

In most cases, emergent organization seems to arise from the ordering of numerous **lower level elements**, which become the building blocks of the **higher order whole**.

Such a **process** must be at work when molecules become ordered in crystals or in polymers, or when **cells** become arrayed in tissues and **organs**, or when insects or people as individuals become participants of complex **social systems**.

2416

ORGANIZATION (Epigenetic evolution of)^{1) - 2)}

According to J.P. CHANGEUX, in biological **evolution**: "... at the higher **levels** of organization... there is also a so-called epigenetic **evolution** in the individual, without modification of the genome. The varying **elements** are the neurons: their number and, most of all their **interconnexions**" (1992, p.707).

"At the highest **level**, "reason" links between groups of neurons do appear, **programs** of action and reasoning do develop" (p.706).

It seems to be a constant of **evolution** that, at some states, higher **levels of complexity** emerge *through association* of **elements** of the immediately lower **level**. C. BRESCH, tackled this subject globally in his book "Zwischenstufe Leben: Evolution ohne Ziel?" (1977).

BRESCH describes the following **levels** of organizational **emergence** through **association**: Atoms from elemental particles; molecules from atoms; polymers from molecules; protobionts from polymers; **cells** from protobionts; pluricellular **organisms** (plants and animals) from **cells**; **groups** from animals. In a similar fashion CHANGEUX shows the **emergence** of neurons from atoms through **association** between neurotransmitters, neuropeptides, enzymes, etc.; and the **emergence** of the highly organized **brain** through **association** between **groups** of neurons.

A similar **emergence phenomenon** seems presently at work among men and may signal the **emergence** of a planetary super-**organism**. **Association** between simple **robots** could seemingly also lead to societies of cybernetic **organisms**.

2417

ORGANIZATION (General Theory of)^{1) - 3)}

According to K. BOULDING: "The general theory of organization begins with the concept of **homeostasis**; that is of a **mechanism** for stabilizing a **variable** or a group of **variables** within certain **limits** of tolerance. Every **organism** or organization is characterized by a group of such **variables**, and the organization consist mainly in more or less elaborate apparatus to maintain these **variables** between an upper and lower **limit**. Should any of the essential **variables** rise above the upper **limit**, machinery must be brought into play to reduce it; should it fall below the lower **limit**, machinery must be brought into play to raise it. An organization in this view consist of an **aggregate** of such governing **mechanisms** sometimes called **control mechanism** or **feedback**" (1952, p.36).

A **feedback** is not really per se a **control mechanism**, but only an essential **part** of it.

Moreover this formulation (dated 1952) does not escape from the critique of "**mechanistic reductionism**" that has been frequently directed at WIENER's **cybernetics**. Nearly all the important contributions of ASHBY, von FOERSTER, MATURANA, MARUYAMA, and many others did appear after 1952.

According to Rafael RODRIGUEZ DELGADO (1997, p.25) a General Theory of Organization should cover the following subjects: "**Wholeness, growth, differentiation, hierarchical order, dominance, control, competition and teleology**, whose **parameters** are not easily measured... Moreover, organization implies a **configuration of interrelations (communication, information)**, ordered and coherent, of the inside of the systems and of groups of systems"

The growing use of **networks** to explain intelligent structures or to construct them (see "**connection machine**") brings now a still newer dimension to our **concept of organisation**.

2418

ORGANIZATION ("Good")^{1) - 2)}

Basing himself on a comment by ASHBY according to which the properties of **constraints** "are not intrinsic to the thing but are relational between **observer** and thing" (1968, p.109), W.R. WINBURN states: "This means that no organization can be good, useful, functional, etc., in any absolute sense; rather, such qualities are relative to the **context** or viewpoint of the **observer**. Yet, for any given **context**, we find that good organization is of the nature of a relation between the **set of disturbances** and the system's **goals**" (1991, p.562).

"Good" seems here to express **fitness**. Still, our **appreciation** of fitness is always an **observer's** view. However, systems, well or ill organized, survive or perish independently of

their **observers**. We need thus to sharpen our **observation** in order to limit discrepancies between what we see as "good" or "fit" and what it may be for the **concrete system** we are interested in.

2419

ORGANIZATION (Hetero-)²⁾

According to E. PESSA: "It is commonplace ... to speak of **self-organization processes**, but it would be better to speak of hetero-organization; that is, the **control parameters** are driven by the external **environment**, without any possibility for the (dynamical) system to counteract this influence" (1992, p.434).

This means that the system is self-organizing only as far as such **process** remains compatible with the **environmental** basic conditions. An oxygen-breathing **living system** cannot anymore organize itself if its **environment** becomes suddenly devoid of oxygen.

Without reaching such an extreme case, the system "... can ... follow, in a passive way, the **behavior** of the external **fluctuations**, whose role, on the other hand, is only that of making explicit the richness of dynamic **behavior** implicitly contained ... in the **form** (of the system)" (Ibid).

In other words, as stated by von FOERSTER, **noise** can be a **source of order** for a dynamic system.

2420

ORGANIZATION (Holographic)^{1) - 4)}

Inspiring himself from several sources, J. JOHANNESSEN proposes the following requirements and **criteria** of a holographic or **heterarchical** organization:

1. The **whole** enclosed in its **parts**
2. **Double-loop learning** (deutero-learning), with communicative **competence**
3. Fewer **levels of management**
4. Liquidation of a centrally managed **command and control model**
5. The transition to a "flatter" organizational **structure**
6. Clearly defined **goals** leading to **action**, where the results, plans, and **goals** can be evaluated explicitly
7. More emphasis on individual responsibility for contact and **communication**
8. More emphasis on the overall view
9. Organizational **design** favoring innovations and **autonomy**
10. The gathering of **information** a more distributed **process**
11. The transition from **data** processing to complete **information** systems.
12. **Flexibility** and freedom for the individual members of the organization
13. Involvement by all in the **planning process**
14. Creating the future, not predicting it

15. **Cybernetic** principles as the foundation for organizational **design**

16. **Self-organizing, autonomous** small **groups**

17. Global **information** can be taken out locally and local **information** can be taken out globally. In holographic terms: each **part** of the organization contains enough **information** to recreate the **whole**" (1991, p.41-42).

Such a proposal seems viable only if the cultural conditions (i.e. the **environmental meanings** and **values system**) supports its sub-jacent postulates, which is surely not the case in several cultures, where personal responsibility is not strongly recognized,, or is recognized merely within an authoritarian **frame**.

2421

ORGANIZATION (Law of optimum size of an)^{1) - 4)}

"The larger an organization grows, the longer is the way of **communication**, and this, depending on the particular nature of the organization, acts as a limiting factor and does not allow an organization to grow beyond a certain **critical size**" (L.von BERTALANFFY, 1956, p.7).

This law, stated by BERTALANFFY was enounced by K. BOULDING. It applies in depth as well as in extension. The geographical extension, for example, that an organization is effectively able to embrace and maintain depend on the nature and importance of its **communication means** and of its capacity to maintain the corresponding **net** in good functional state. It is also the case with any internal **communication net**, not anymore in a geographical sense, but from the viewpoint of its **density**. In the first case, disruption risks appear due to excessive stretching beyond some **limit**, or because of a growing **noise** in the **channels**. In the second case, there is a risk of **overcrowding** and overtightening, due to **competition** between too numerous **elements** which try to use simultaneously a **net** whose capacity is saturated or exceeded.

2422

ORGANIZATION (Levels of)^{2) - 4)}

According to R. ROSEN, a system is "... **hierarchically** organized if it satisfies the following two conditions: a) the system is engaged simultaneously in a **variety** of separate distinguishable **activities**, and b) different systems **descriptions** are necessary to describe these several **activities**. It is this second condition which characterizes biological systems, with their stratification into many **levels** of organization" (1972, p.59).

A good example of organization through levels is given by J.P. CHANGEUX, describing the successive levels of neural organization in the **brain**:

- individual **connections** between neurons
- elemental **circuits** of a reduced number of neurons in charge of specific reflexes **functions** (walking, swimming, bicycling, etc.)
- more complex **clusters** of associated neurons able to codify more abstract **representations**
- **clusters of clusters**, corresponding in the human **brain** to the highest mental abilities: reasoning, **planning**, etc. (1992, p.706).

There appears to be a progressive **algorithmization process** at different levels.

One may wonder if the same type of **processes** is not a general feature of **emergent** social **organization**. It seems to characterize the present **process** of globalization of human **social systems**.

see figure below

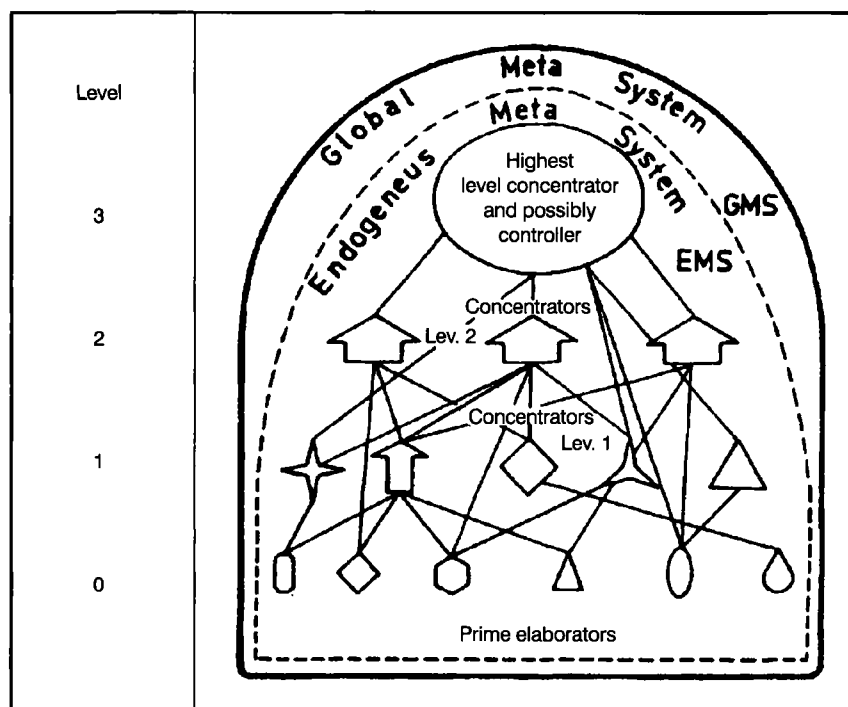
2423

ORGANIZATION (Levels of) according to J. MILLER^{1) - 2) - 4)}

In his "Living Systems" (1978), MILLER introduced seven levels. Later on, he added the "**community**" level, in-between the "**organization**" and the "**society**" (1990, p. 158).

MILLER's **taxonomy** of levels of **organization** refers to **living systems**. It thus excludes physical ones, as for instance the solar system. Its **meaning** is different of, but not incompatible with LE MOIGNE's **nine levels** (see hereafter)

Figure: see entry ORGANIZATION (Levels of)



Organization levels: An ecological example

From C. FRANÇOIS: 1987, p. 71

MILLER's levels are ordered with reference to their growing **complexity**. They are:

- the **cell**, composed of different interacting organelles, as nucleus, mitochondria, ribosomes and Golgi apparatus;
 - the **organ**, internally organized as composed of different classes of **cells**;
 - the **organism**, a globally organized complex of various types of interacting **organs**;
- These are the three purely biological **levels**.

The next five ones are sociological;

- the **group**, a reunion of **organisms**, endowed with different capabilities and collaborating in pursuit of some common **goal**, as a family;
- the **organization**, a **group of groups**, also endowed with specialized capabilities, and pursuing a global **goal**, in need of a good coordination of specific sub-goals, as an industrial plant;
- the **community**, a complex of **organizations**, seeking still more general and complex **goals**, as a city;
- the **society**, an articulated complex of **communities**, with global meta-goals, as a nation;
- the **supra-national system**, with **goals** common to various national societies, as the European Union, or the United Nations Organization.

It would be interesting to find out the possible application of some similar **taxonomy** to insect societies, for example, or to **ecological communities**.

2424

ORGANIZATION (Modes of)²⁾

J. FEIBLEMAN and J. FRIEND classify organizations as **wholes** into various kinds. They write: "The kinds of organization constitute degrees of integrality, as follows:

a) **Agglutinative**: the governing **relation** is **aseriality**, where **parts** have **intransitivity**, **connexity** and **symmetry**.

b) **Participative**: the governing **relation** is **seriality**.

Participative organizations subdivide into three kinds, as follows:

a) **adjunctive**: The governing **relation** is **symmetrical independence**. The sharing of **subparts** is not necessary to either of the **parts**. **Parts** can survive their separation.

b) **subjective**: The governing **relation** is **asymmetrical dependence**. The sharing of **parts** is necessary to one of the **parts**, but not to both.

c) **complemental**: The governing **relation** is **symmetrical dependence**. The sharing of **parts** is necessary to both of the **parts**. Neither **part** can survive separation..." (1969, p.36).

The authors observe that: "The division of organizations into various kinds is not arbitrary, although there are other classifications that could be made. The present one is made specifically according to the governing **relations** of the organizations. It needs to be pointed out that this classification is ideal in the sense that no actual organization ever completely answers to it" (1969, p.36).

2425

ORGANIZATION of a SYSTEM^{1) - 2)}

According to G. KLIR: "If the system is to exhibit a particular **behavior**, it must possess... certain properties which we call the organization of the system. Since, according to the definition given, the **behavior** of the system can change (from the viewpoint of local **relations**), we must assume that its organization can also change. It will be of advantage to define the constant and the variable part in the organization of the system" (1965, p.31).

This is a quite classical **structural** and **functional** view of organization in systems. It should be compared with the ulterior **autopoietic** understanding of **organizational closure**, according to which organization is a **cyclical** (M. EIGEN would say **hypercyclical**) property of the system as a **whole**.

A closely related view is also offered by the **autopoiesis** concept. In M. ZELNY's words: "A **network of interactions** between the **components**, renewing the system as a distinct unity, constitutes the organization of the system. The actual spatial arrangement of **components** and their **relations**, integrating the system temporarily in a given physical milieu, constitutes its **structure**" (1984, p.13).

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

There are however some dubious cases, as for example petrified wood, which is not anymore wood, but has for eons conserved through chemical **transformations** the organization (or **structure**?) of the original system.

As to the constant and the variable **parts** in the organization, it is, at least for practical purposes, a matter of the **time scale of observation**.

2426

ORGANIZATION, ORGANISM: A semantic comment³⁾

R.W. GERARD tried to put some order among the **meanings** of different words related to the concept of organization (1950).

He wrote: "The word 'organism' has been used in two senses; a more specific one, referring to living organisms, and a more general one, which includes as well nonliving systems, possessing certain properties. Since I shall have to use both **meanings**, I have found useful, to avoid confusion, to introduce the term 'org' for the broader **meaning** of organism, and to reserve the full word for the biological subgroup" (1956, p.155).

GERARD did not use the word "organization", but proposed two other neologisms:

- "animorg", designating **living systems**, as opposed to non living ones;
- "epi-organism", designating **colonies** or social systems composed of **living systems**.

Later on, von FOERSTER proposed the term "**artorg**" to denominate organized artificial systems. None of these neologisms became really accepted... and it seems unfortunate, because they characterized important **distinctions**.

Moreover, the word "organization" gives also way to at least two different **meanings**:

- to designate the **set** of any systems' **structures and functions**;
- To designate a specific type of **human systems**, which numerous **elements** assembled in more or less well defined **structures**, according to the functional necessities of the system. (See for example A. RAPOPORT & W.J. HORVATH, 1959; M. HAIRE, 1959; G. VICKERS, 1957).

2427

ORGANIZATION (The nine levels of) according to J.L.E MOIGNE^{2) - 4)}

This classification responds to purposes different to MILLER's, but is in no way contradictory nor incompatible.

J.L.E MOIGNE (1977, p.97-112) describes the following nine **levels of modelization** of the organization of the "**objects**" (a term comparable to "system" for the more differentiated levels):

- The **passive object**: which, simply, exists and in most cases corresponds to a quite elemental level: an atom, a molecule, a crystal, a planet, a word.
- The **active object**: which takes part in some **activity**: the atom which gives cohesion to a molecule, the word which has a specific sense in a sentence.
- The **regulated object**: Which counts with an internal device selecting its future **behavior** in relation to its former one, by way of some **feedback** of the **output** on the **input**.
- The **informed object**: which possesses an internal device including a register of its previous **states** allowing in **association** with the **feedback** device, for conditional **behaviors**.
- The **object fitted with a decider**: which acquires a device allowing it possibilities of alternative **choices** in relation to the available **information**, "when the **action** of the system is an **event** for which occurrence no **change** in the **environment** is necessary, nor sufficient" (ACKOFF, 1971) or "when not being unavoidable, the **choice** of the **action** must be decided by the **object** itself" (LE MOIGNE, 1977, p.103).
- The **active object, endowed with memory**: i.e. fitted with a **repertory** of former **situations and actions**, which permits the definition of **decision criteria**. LE MOIGNE observes: "A **decider** without **memory** and whose **behavior** would not be aleatory, can only be an **algorithm**" (p.107). The **memory storage** implies the existence of a "memorization **processor**" which provides the internal **representation** of the **information**.
- The **coordinated active object**: which carries on multiple **decision processes** related to multiple operative **processes** and is fitted with a general arbitration **processor** which decides between the various necessities in charge of specialized **processors**. According to LE MOIGNE, the concept of **coordination** is better than the **integration** concept, as it "refers to a **function** that must be ensured, but not necessarily to an imperative project" (p.111).
- The **imaginating active object**: in which some **processors** are able to interpret **information** that, for others, is mere **noise**. In such conditions, new **connexions** may appear among **processors** within the system and modify its **behavior**. **Self-organizing** capabilities emerge, correlated to **learning behaviors** and **emergence** of intelligence.
- The **self-finalizing active object**: The **object** acquires "the ability to create its own projects: if it can be finalized it may also be finalizing" (p.115). LE MOIGNE thus quotes J. MELESE: "The finalities of a system cannot be understood, and still less be constructed if not in relation to its **connexions** with its surroundings... The system... may be charac-

terized as the **interface** between a finalizing will and an **environment**" (MELESE, 1972, p.53).

LE MOIGNE admits, however, that this "finalizing will" is still an imprecise concept" (p.115).

According to LE MOIGNE, the first four levels constitute the field of mechanics, while the last five pertain to **systemics**. LE MOIGNE's text is illustrated with figures that quite enlighten the nature of these nine levels of organization.

2428

ORGANIZATIONAL CLOSURE^{1) - 2)}

The concept of organizational closure does not mean that the system is **isolated**, nor even that it is **closed** or nearly closed.

No system can survive without **assimilation** of various **classes** of **inputs** flowing from its **environment: matter, energy, information**.

However, the system could not survive if these **inputs** should disorganize it and destroy its **cohesion** and **identity** (something which however happens frequently in the real world).

Organizational closure refers to the conservation of the systems basic **structures** and **processes**. This is obtained through its capacity, thanks to internal **operators activity** (corresponding to **operational closure**) to:

1°- transform its **inputs** to make them useful to its correct functioning (**assimilation**). It should be noted that "**inputs**" are not to be given the same **meaning** as in the **behaviorist** direct **deterministic** view of "the **stimulus** for a specific **response**".

2°- transform its internal **states** to compensate, if needed, any **disequilibrium** resulting of the absorption of foreign **elements** (**adaptation**).

These **transformations** may be **cyclical**, or **hypercyclical**, but the number of possible **states** is necessarily limited, while however it may be very high.

VARELA states: "It is as if once the closure of the system is achieved... it automatically takes care of the generation of its internal regularities" (1984, p.26). Or "... **inputs** become a **perturbation** or **noise** when they are no longer necessary to the systems' **organization**." (GO-NELLA, 1976, p.312).

On the other hand, **organization** should not be confused with **structure**: "(The system's) **organizations** are the necessary **relations** which define the system and its **structure**... are the actual **relations** between the **components** which integrate the system as such. Thus ex-definitione the **organization** is **invariant** while a system maintains its **identity** without disintegration; **structures** can vary provided they satisfy the organizational **constraints**" (VARELA, 1975, p.25).

And moreover... "From an **input** type stance, a system is adaptative because it is optimally **fitted** to a given world. From a closure type stance, a system is adaptative simply because *its organization is maintained invariant* through **changes of structure** which do not violate **constraints**" (p.27).

Such a state of affairs may however block necessary **adaptations** when the "given world" undergoes some basic **change**. Accordingly, G. BROEKSTRA states: "Organizational closure is essentially a **non-equilibrium** concept akin to **autocatalysis** and underlies the ordering principle of **order through fluctuation**" (1993, p.78).

One wonders if VARELA would have admit this extended interpretation, at least for biological systems.

2429

ORGANIZATIONAL CLOSURE: A Critical Study^{1) - 3)}

F. BONSACK evaluates critically F. VARELA's concept in the following terms:

"His system is as follows: There is, basically, a causal **net**, internal to the system; the **components** mostly interact: He speaks about "organizational closure". Of course, he makes clear that "closure" is not the equivalent of "closedness". However it is not less true that the first looks much like the latter and that the only noteworthy difference is that it accepts "**perturbations**" to which the internal **net** of **interrelations** reacts globally, reinstating **equilibrium**. What is generally called **information**, for example the sensations, are reduced in that way: there are not **inputs**, but only **perturbations**.

"And the **outputs**? One looks in vain for them: the system closes on itself, it does not act outward. VARELA gives at page 225 of his book "Principles of Biological Autonomy", a schema where a **net** of **interactions** may be seen: an arrow coming from outside but no arrow pointing outward. In his NEUCHATEL conference, he described at large an annular **cellular automata**, which he presents as a **model** of **autonomous** system. Again, arrows may be seen coming from outside, but none directed outward. He writes explicitly: "I say "closure" in the sense that any intersection of the system leads *not to a response towards the outside* (BONSACK's emphasis), but to a new **interaction** within the system itself". And farther on: "The consequences of the system's **operations** are system's **operations**". The system thus closes on itself.

"How to understand this curious stand?

"The most plausible hypothesis is that, for VARELA, the system's **activity** is centered on its own conservation, on a continuous **autopoiesis**, on the defense of its own integrity – which may be admitted.

"However VARELA seems to forget two aspects:

"The first one is that, according to his own theory, **autonomous** units may fuse to form an **autonomous** unit of superior **order**, for example a **group** of individuals, a society, a culture. And, in such a **frame**, the inferior units must necessarily produce an **output**, providing something to the other units, or performing some **function** within the **frame** of the superior unit. Contrarywise, no superior unit could exist, these would be only a collection of inferior units, all closed on themselves, without links or **interactions**.

"The second aspect that VARELA seems to forget, is that, among the retroactive causal chains which permits the **maintenance** of the individual's integrity, many do not remain internal, *but cross through the world*. Let us think for example to the search for food!

"This entails two consequences:

"Firstly: as the chain crosses outward, there is an **output** when it exits from the system and, at least, one **input** when it comes back.

"Secondly: if the chain is to be efficient, a **knowledge** of the world must exist, of the **objects** and the causal **relations** that are to be used. It is thus unavoidable, in one way or another, that the system be equipped with a world **representation** that will permit it to simulate the **objects behavior**. It is thus unavoidable for it to count with genuine **information inputs** (which are something different from **perturbations**) in order to be able to create that world **representation**. Yet, VARELA rejects not only any **input**, but altogether any world **representation**. He writes (I translate):

"In this perspective, what we call "**representation**" is not a correspondance with some kind of given **state of matter**, but better, a **coherence** with the continuous **maintenance** of its own **identity**. Such regularities ("behavioral regularities") which we choose to call "symbolic", are *not* operative for the system, because it is *us* who establish a correspondance from a viewpoint which is not within the **operation** of the system" (end quote).

.....

"One has the impression, reading VARELA, that he attaches a positive value to anything internal to the system, while all that is external is negatively valued: For example, **information** become a "**perturbation**". For him, the outside is the ennemy of the autonomous system" (BONSACK, 1990, p.110-112).

P. CARIANI, inspired by G. PASK, relates organizational closure with "the self-construction of the **observer**". He writes: "When a device gains the ability to construct its own **sensors**, or in Mc CULLOCH terms "this ability to make or select proper **filter** on its **inputs**", it becomes organizationally closed. The device then controls the **distinctions** it makes on its external **environment**, the **perceptual categories**

which it will use. On the **action** side, the device acquires the ability to construct its own **effectors**, and with them gains **control** over the kinds of **actions** it has available to influence the world. The self-construction of **sensors** and **effectors** thus leads to an **epistemic autonomy**, where the **organism** or device itself is the major determinant of the nature of its **relations** with the world at large... This basic concept of structural closure and its consequent, functional **autonomy**, underlies many of the closely related notions of *semantic closure* (PATTEE), *autopoiesis* (MATURANA, VARELA), self-modifying systems (CSANYI, KAMPIS), **self-reproducing automata** (von NEUMANN), **anticipatory** systems (ROSEN) and the recurrent "**nets with circles**" of Mc CULLOCH and PITTS" (1993, p.30).

In synthesis, organizational closure can, and must be *acquired*, even if on the base of a primeval biological level of closure.

Finally, CARIANI makes the following and very significant comment about programmed devices: "They fail to achieve **epistemic autonomy** relative to their designers because all possibilities have been prespecified by their designers" (p.30). This means that externally imposed **algorithms** preclude the formation of internal ones.

G. PASK clarified these aspects as early as 1958 and 1961(b). Possibly too early to be well understood!

2430

ORGANIZATIONAL DEPTH³⁾

"A system's organizational depth is measured by the degree of nesting of sub-ordering relations within its global ordering **relation**" (W.O. CHRISTENSEN & C.A. HOOKER, 2000, P. 136)

The best global examples of organizational depth can be found in J. MILLER's **taxonomy of living systems**, either **bottom up** from the **cell level** to the global supra-national system, or vice versa. Neither the down-level **subsystems** can survive if not integrated into a higher-level one, nor the higher-level system can maintain itself if it does not satisfactorily integrates its subsystem in a coherent manner.

Conversely, a crystal, while structurally organized, has no organizational depth, as its **parts** can generally be cleaved without being destroyed, not being functional in any way.

→ **Complex (Supremacy of the); Priority of the simple**

2431

ORGANIZATIONAL LEARNING^{2/4)}

K. BAUSCH describes organizational learning as follows: "A **process** of developing organizational capacity and human capability to articulate and continually examine the **purposes**, underlying perspectives and **assumptions**, and individual and organizational **values** in view of

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- a) the **performance** of the **organization**
- b) the changing characteristics and expectations of the **environments** in which the organization is **embedded**" (Glossary, Pers. comm., 2002)

This is in fact the program of the "**Evolutionary Learning Community**" (ELC)

- The following aspects seem most important:
 - the nature and conditions of learning (general and specific) should be deeply researched
 - a thorough critical examination of all assumptions and values should be undertaken and periodically repeated in order to avoid **underconceptualization**
 - purposes should be examined in a similar fashion
 - the aim is not to find recipes, nor solutions. It is to create evolutive **design**
 - the designers should avoid **clanthink**, be aware of possible **blindspots**, escape from "politically correct" rules and develop **creativity**.
- **Design (Systemic approach to); Design (Generic); Design methodology (Systemic); Group technique (Nominal); Interpretive structural modelling; Organization**

2432

ORGANIZATIONS' DESIGN and OPERATION ⁴⁾

According to ACKOFF: "... one who wants either to create an effective organization or to improve the **operation** of an existing one... has four basic types of approach to organizational **effectiveness** and combinations thereof. The basic types of approach correspond to the four essential **characteristics of organizations**." (see here upon: "**Organization as a system**")

B. BANATHY differentiates the characteristics of old style or new style organizations (see 1993, p.248).

Older organizations tend to **dynamic stability** obtained through **hierarchical control**, a generally closed logic and the search for **efficiency** focused on **short-term goals**.

Newer organizations admit shared power, **cooperation**, **long-term** perspectives and **creativity**.

It should be observed however that, as organizations of the second type (in business, politics, science, etc...) tend towards **stabilization** and maturity, they also derive towards the first type.

2433

ORGANIZER ²⁾⁵⁾

Some biologists – among them H. SPEEMAN – discovered that the amphibian embryo contains a section that has the potential to induce and to promote-when grafted in another embryo- the

appearance of a second embryo, in many cases complete. This section has been called "organizer"

C. WADDINGTON described in detail this **process** of embryonic **determination** as a sequence of progressive **constraints** on the original **equipotentiality** condition (Waddington's inverted cones, as a diagrammatic way of representing this course of embryonic determination) (See J. NEEDHAM, 1968, p. 58)

The organizer is also a feature of WADDINGTON's **morphogenetic fields**. for his part, the Belgian biologist A. DALCQ tackled the organizer concept in his 1940 book.

Of course, a disquieting question mark remains: "How does the organizer appear?" , as for example in CSANYI's proposed **zero-system model**.

Another intriguing point is the possible existence of organizers as features of complex biological and of metabiological systems. On this point, NEEDHAM writes: "It was soon recognized that the organizer **phenomena** were not confined to amphibia, for parallel cases were found in echinoderms (HÖRSTADIUS) insects (SEIDEL), and birds and mammals (WADDINGTON) (p. 83)

And could the organizer model be translated to meta-biological and **social systems**?

→ **Autogenetic system precursor; Bifurcation; Gradient; Morphogenesis; Nodal activity; Positional value; Threshold; Zero-System**

2434

OSCILLATION ²⁾

A more or less **periodic change** of the values of a **function** in a system.

Oscillations can be: regularly sinusoidal; of relaxation; **periodic** but complex (i.e. composed of various sinusoidal oscillations of different **frequencies** and **amplitudes**); mixed **chaotic** and **periodic**, or totally **chaotic**. (I. PRIGOGINE, 1984, p.55)

In **dynamic equilibrium** conditions, they are generally steady or progressively **damped**. **Far- from- equilibrium**, they become amplifying **fluctuations** and finally lead the system over an **instability threshold**. This in turn is conducive either to its destruction or to its **emergence** at a higher **level of structural and functional complexity**.

The **homogeneous steady state** could be considered as non-oscillatory.

Oscillations can be an effect of **time lags**.

This has been demonstrated long ago by VOLTERRA and LOTKA's study of the **population's fluctuations**.

More recently, it is a characteristic feature of J. FORRESTER's **Systems Dynamics**.

This is quite understandable, as the corrective **action** of any **regulator** is *always late*: its impact is felt on the controlled **value** when other **variations** already changed the **value's level**.

P. MANZELLI states (with reference to biochemical **processes**): "...oscillating reactions show an **auto-organized action** that needs the supposition that the interacting particles can "communicate **information**" among themselves to establish a global **behavior** of the **space/time transformation** of the **reaction**" (1993, p.334).

This **process** results generally of intricate **sets of feedbacks**, as in **catalysis** or **hypercycles**.

2435

OSCILLATION (Reverberating) ^{2) - 4)}

An unendingly repetitive **transformation** from which the **process** or system is not anymore able to escape.

St. BEER writes: "... when this happens in the **brain**, the subject is called neurotic. Official politics, particularly in the field of economic affairs, seem to be given to such neuroses"(!) (1968, p.477).

A system captured into this kind of rut is in great danger, because it has lost its **adaptive-ness**, frequently in an irreversible way.

2436

OSCILLATION (Self-) ²⁾

An oscillation that appears spontaneously in a system.

This curious phenomenon has been first researched by POINCARÉ. S. DINER describes as follows its characteristics:

- "**amplitude** and **frequency** independent of **initial conditions**;
- "**emergence** independent of any external **periodic** stimulation;
- "**control**, through **feedback**, upon the **energy source**, in order to compensate **dissipation** without influencing **amplitude** and **frequency**".

DINER defines an auto-oscillator as : "A system generating non-**damped** oscillations, sustained by an external **energy source**, in a **non-linear dissipative** way, and whose aspect and properties are determined by the system itself, without **dependence** from its **initial conditions**. In such conditions, oscillations can be not merely **periodic**, but also **quasi-periodic** and even stochastic. ANDRONOV (in 1929)... showed for the first time the physical existence of an **attractor** that was not an **equilibrium point**. Later the concept of **attractor** was to be amplified up to the emergence of the **strange attractor** concept, the mathematical form of stochastic self-oscillations" (1992, p.340-1).

This could be considered a kind of **thermo-dynamic autopoiesis**!

2437

OSCILLATIONS (Shortening) ²⁾ - ⁴⁾

W.D. GROSSMANN and K.E.F. WATT stress that "there is an increase in **amplitude** and decrease in wavelength of all major **wave-like oscillations** in society... This gradual decrease in wavelength is striking in **graphs** plotting year by year, from 1740 to the present, the wholesale price index adjusted for its long-run **trajectory value**".

This implies a rapid "decrease of **time-spans** for **reactions**" with the aggravating factor that economic and political leaders are generally unaware of this **situation**.

The authors give other examples and evaluate this **phenomenon** as of "Severity rating 1" (1992, p.35).

This **phenomenon** is closely related to **evolutive acceleration** and both seem to indicate the progressive **dominance** of **chaotic behavior** in **human systems**, highly probably in relation to the exponential **growth** of **energy** use.

2438

OSCILLATOR ²⁾

"Any system that executes **periodic behavior**" (S.H. STROGATZ and I. STEWART, 1993, p.68).

These authors give the most simple and classical example, the pendulum and comment that "... it returns to the same point in **space** at regular intervals; furthermore, its velocity also rises and falls with (clockwork) regularity". They add: "A simple pendulum consisting of a weight at the end of a string can take any of an infinite number or closed **paths** through **phase space**, depending on the height from which it is released".

This corresponds to the **linear** or harmonic oscillator mathematical **model**, related to **FOURIER analysis of periodic functions**.

Moreover: "Biological systems (and clock pendulums), in contrast, tend to have not only a characteristic **period** but also a characteristic **amplitude**. They trace a particular **path** through **phase space**, and if some **perturbation** jolts them out of their accustomed **rhythm** they soon return to their former **path**" (Ibid).

However, an oscillator with many interfering **frequencies** not in **harmonic** relations behaves – or seems to behave – **randomly**. This is the case of the forced oscillator, in which the introduction of a **perturbation** disturbs the regular **periodic behavior** and induces it in a partly, or totally **aperiodic**, or **chaotic** movement.

In complex systems with a supposedly **deterministic behavior**, such a **perturbation** normally leads to a greater **unpredictability**.

S. STROGATZ and colleagues have shown and mathematically proven that collection of oscillators, whose **frequency** can respond to those around it, will end up in **synchrony**.

This is a deep and very general discovery which establishes a basic **model** for the spontaneous **emergence** of **order**, out of apparent disorder.

The first observation of synchronization was made by the Dutch physicist Chr. HUYGHENS (1629-1695), between two clocks

→ **Belousov Zhabotinsky reaction**; **Order**; **Network**; **Smallworld**; **Synchronicity**

2439

OSCILLATOR (Limit cycle) ²⁾

"An oscillator that has a standard **wave-form** and **amplitude** to which it returns after small **perturbations**" (S. STROGATZ and I. STEWART, 1993, p.68).

The authors explain how such oscillators work: "They incorporate a **dissipative** mechanism to **damp oscillations** that grow too large and a **source** of **energy** to pump up those that become too small" (Ibid).

In the case of **living systems**, the result is **homeostasis**, acquired through suitable **regulations** and the use of stored **resources**. P. VENDRYES' counter-aleatory **reserves** concept is closely related.

2440

OSCILLATORS ²⁾

The theory of oscillating **processes** and systems has been developed in successive steps, its **models** progressively nearing the concrete **situations**.

The simplest oscillator shows a regular and invariable **periodic behavior**. It does not take into account the degradation of **energy** which results, for example, of frictions. This type of oscillators is neither **time-dependent** nor **environment-dependent** and can be described by any **function** characteristic of **non-dissipative processes**. It has no **attractor**.

However, such a **model** is totally abstract and theoretical, in close **relation** to the concept of **isolated system**, in use in **classical thermodynamics**.

Conversely the next **model** of oscillator considers the **irreversible dissipation** of **energy** and **growth** of **entropy**. In this case, more realistic, the system's **trajectory** tends to a final point of **static stability**, i.e. a point of **attraction**, or simply, an **attractor**.

This is the case, for example of a pendulum that receives no supplementary **energy** from its **environment** and is thus not able to compensate for the monotonous loss of usable potential. The **behavior** of this class of oscillators is defined by a positive and monotonously decreasing **LYAPOUNOV's function**, corresponding to the progressive **damping** of the **amplitude** of their movements.

There are however numerous systems which cannot be represented by such a **model**: those which receive from their **environment** an **energy** supply equal or superior to the **energy** that they are able to dissipate. In the first of these cases, the system heightens its **entropy** production up to a **level** at which it becomes able to maintain its **dynamic stability** for a long time. (**Equilibrium thermodynamics**). This case corresponds to the emergence of a **stable limit cycle** characterized by a **VAN DER POL's attractor**.

If the **energy input** becomes superior to the **dissipation** capacity of the system, it will undergo uncontrollable growing **fluctuations**, eventually cross a **threshold**, become unstable and pass through **bifurcation** points corresponding to deep alterations. This may lead to **chaotic behavior** and the future of the oscillating system becomes unpredictable.

2441

OSCILLATORS (Coupled) ²⁾

Oscillators that influence one another and become synchronized.

This intriguing property was discovered by Chr. HUYGHENS in 1665.

S.H. STROGATZ and I. STEWART state: "Coupled oscillators can be found throughout the natural world, but they are especially conspicuous in living things: pacemaker **cells** in the heart, insulin-secreting **cells** in the pancreas; and neural **networks** in the **brain** and spinal cord that control such rhythmic **behaviors** as breathing, running and chewing. Indeed, not all the oscillators need be confined in the same **organism**: consider crickets that chirp in unison and congregations of synchronously flashing fireflies" (1993, p.68).

A mathematical theory of coupled oscillators has been developed and new angles have appeared recently through the **chaos theory**. The subject is obviously related to the composition of oscillations of different **periods**, but the way through which the significant "**information**" passes from one system to another is still in many cases not clearly understood.

Coupled oscillators must also have some relation with HAKEN's **slaving principle** and are an obvious necessity in organized systems and even in more or less synchronized **quasi-systems**, as for instance fish **swarms** (see D. RITZ, 1991).

2442

OSCILLATORS (Systems of) ²⁾

Transitions between some uncoordinated **state** of numerous **elements** and their grouping as a **composite system**, or even an **integrated** one may be interpreted as the **coupling** of numerous **oscillators**, which **behavior** becomes **phase locked**.

This can be exemplified by amoeba, fish, or fireflies, or locusts **swarms**, and probably in the dynamic groupings of **neurons** in the brain. The condition for such a **transition** is the existence and sufficient power of a **communication mode**, which can be biochemical, or electric, visual or auditive.

2443

OSCILLON²⁾

A very simple oscillating **pattern** obtained by vibrating a thin layer of sand grains.

The oscillon was discovered by Paul UMBAN-BOWAR, Francisco MELO and Harry SWINNEY (Univ. of Texas at Austin).

It seems to be the very fundamental **self-organizing pattern** obtained by **energy dissipation** and leading to **structuration**.

Oscillons, according to SWEENEY, "can join together to form chains, triangular associations and even extended **lattices** - and all are stable". (as quoted by Marcus CHOWN, 1997).

CHOWN adds: "The square **lattice** (would be) simply the lowest-**energy configuration** of an even mix of attracting and repelling particles... (as in) an antiferromagnetic **lattice** (in which) each positively charged particle is surrounded by four negatively charged particles in a square **lattice**" and, ... "By contrast, the lowest **energy configuration** of like-charged objects is a **hexagonal lattice**". (p.37)

→ Hexagonal space filling; Order parameter; Soliton; Structure (Dissipative); Symmetry (Hexagonal); Vortex

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ÖSTERREICHISCHE STUDIENGESellschaft für KYBERNETIK

→ Austrian Society for Cybernetic Studies

2445

UGHTNESS: Two complementary systemic meanings^{3) - 4)}

There are two different identifiable **meanings** in systemic terms to the **concept** of "oughtness" as introduced by A. BAHM (1978 - 1992).

The **regulation** of road traffic offers a good example. First, traffic ought to be organized through **rules** in order to make it efficient as a transportation system. This includes priority **rules**, overtaking **rules**, maxima and minima speed limits, a **code** of traffic lights and other road **signals**, etc... This "oughtness" is related to a sound **organization** and **regulation** of a very complex **man-machine system**, needed in order to avoid collective anarchy, leading to total paralysis.

Second, these **rules** and **regulations** would be totally ineffective if not obeyed by the human users. This is the "man" part of the **man-machine system** and it implies a sense of personal responsibility in every user.

The traffic **code** must not only be understood as a **set** of integrated **rules**, but also as a system organized for the best welfare of all users, which *ought* to be *respected* for the sake of social harmony. As some users are not understanding this necessity, society as a **whole** created a special social corps - traffic patrols - to attend this non-technical aspect of the traffic system.

Curiously, this last feature introduces *two* quite different ways to understand oughtness: either through one's sense of responsibility, or through the fear of penalties.

These different technical and social ways to understand what could be called techno-social **situations** are at the root of the differences opposing some systemists' point of views, as for example H.A. SIMON and C.W. CHURCHMAN.

→ Systems Philosophy

2446

OUTBREEDING¹⁾³⁾⁴⁾

In a strongly worded critique of social sciences **methodology**, M. MARUYAMA signals one of the most unsatisfactory characteristics of much contemporary specialized disciplines, which is "inbreeding", i.e. the wide ignorance of anything that lies (or seems to lie) outside of the rigidly established limits of their discipline. This leads unavoidably to "**tunnel vision**" and conceptual isolation (1998, p. 91-108)

Obviously he proposes "outbreeding" i.e. the crossing of disciplinary boundaries, as a convenient cure.

MARUYAMA himself "outbred" not only scientifically, but also culturally, during many years, having lived in various European and American countries and, of course, Japan.

Outbreeding of any type triggers a **process** of questioning one own's **concepts** and **frames of references**, which are in many cases unable to contain different ways of **understanding**...and even of **perception**.

If one freely accepts outbreeding, one's original mental and psychical **frames** come under **stress**, sometimes even severe. However, at the same time, **adaptiveness** increases and wider and richer frames of references can be constructed.

It is surely not coincidental that many-maybe most- of the outstanding founding fathers of cybernetics and systems thinking have been expatriates.

2447

OUTLET²⁾

A place in the **boundary** of a system or **sub-system** through which it emits some specific type of **outputs**.

Outlets generally have a closing/opening device which **control** the **outputs** in **time**.

In Spanish, there is a frequent confusion, probably due to incorrect use of accounting vocabulary, between the outlet and the **output**, both named "salida". This term has been now restricted to the **meaning** of outlet, while "**output**" is presently translated as "egreso".

The same problem has been solved in French through the introduction of "intran" (for **input**, in lieu of "entrée") and "extrant" (for **output**, in lieu of "sortie") (R. VALLÉE). However, these terms are not yet of general use.

2448

OUTPUT^{1) - 2)}

"Whatever the system produces and sends back into its **environment**" (B. BANATHY, 1988, p.87).

Outputs can be of **matter**, **energy** or **information**.

Matter emitted has generally been transformed, either upgraded or downgraded. **Energy** is normally downgraded by the system, which uses it to activate its internal **processes**. **Information** is mostly upgraded or even directly created within the system.

Any output has a destination into the **environment** whether fuzzy or precise.

The **whole** or **parts** of the **environment** act as **sinks** for the system outputs. It is very important to know to which extent the **environment** is able to accommodate itself as a **sink**, for, once crossed a **critical threshold**, the system may well suffocate in its own products, be it pollutants, over- production of some item, or over-**population**, for example. This implies the need to study the **rate** of production of every significant output, in order to be able to define **optima** and bearable maxima.

It should be noted that many systems produce some types of outputs while being unaware of it, bringing about some unsuspected **side-effects**, as for a recent example, the ozone hole produced by chlorinated propellants.

Outputs must cross **boundaries** or **interfaces**. The way they do it in **space** and **time** is also a very important feature of the **interrelation** between the system and its **environment**.

Finally, the previous convenient conditioning of the output within the system is of utmost importance in relation to the acceptance by the **environment** and the **reactions** of the latter towards the system.

2449

OUTPUT BOUNDARY²⁾

Any system **function** which relates some system **variable** to **environmental variables**.

This definition equates any boundary with a specific class of **functions** which relates the system with its **environment**. While boundaries are indeed functional (as well as **structural**) one wonders if, for example, internal **organs** in

living systems as, let us say, the digestive tract, should be considered as parts of the boundary and, if so, where to place the **limits** of the system.

2450

OUTPUT PROCESSING²⁾

"The **operations** that identify and assess systems-relevant output and introduce that output into the **environment**" (B. BANATHY, 1973, p.87).

These **operations** correspond to the **activity** of J. MILLER's output **transducers** of **energy**, **matter** and **information**.

2451

OUTPUT TRANSDUCER²⁾

"The **subsystem** which puts out **markers** bearing **information** from the system, changing **markers** within the system into other **matter-energy forms** which can be transmitted over **channels** in the system's **environment**".

This is one of J. MILLER'S **20 critical subsystems in living systems** (1978, p.3). Together with the **ingestor**, the **input transducer** and the **extruder**, it is one of the **subsystems** which communicate the system with its **environment**.

2452

OVERBURDENING^{1) - 2)}

The imposition of an excessive exigence or work on a system.

This notion is closely related to the **overload** one. It corresponds to the often cited proverb about "the last straw that broke the camel's back". However, in many cases, the **operator**, **decider** or manager remains unaware that he is operating close to an **instability threshold**... or crossing it, and the back of the camel breaks.

One of the main causes of such an unawareness is the lack of **perception** and **understanding** of slow **accumulation** of small **effects** in systems at long or very **long term**. This **situation** is particularly dangerous in our time, when all **processes** are becoming interconnected and are accelerating.

2453

OVERCROWDING^{1) - 2) - 4)}

The gathering of an excessive number of **elements** in a limited **environment**.

When **elements** of a system begin to increase considerably in an **environment** that cannot be expanded, they exert growing reciprocal **constraints** on their displacements and, more generally on their **activity**.

This **systemic pathology**, which amounts to a kind of **environmental poisoning**, has been diversely described by, for instance:

- the French sociologist R. BOUDON, who coined the expression of "perverse **effects**";
 - J. CALHOUN in his research on **population density** and social pathology (1962 and 1971);
 - R. ARNOTT and K. SMALL in their study on the economics of traffic congestion (1994).
- The subject is ominously important for any species in full demographic explosion... as ours is.

2454

OVERLOAD²⁾

Excessive **density** of pulses in a **channel** or **set of communication channels**.

Such a **situation** appears when an excessive number of **transmitters** and **receptors** have an access to the **net** and that there is no **control** device to restrict the possibilities to emit or receive **messages** in accordance with the maximal (global or local) capacity of the **net**.

Any overload leads to the disruption of **parts** of, or the whole **net**, frequently through **chain reactions**, (also typical of **composite systems**), which may well be **irreversible**.

The concept can be extended to any **class of nets** (electrical, informative, neural, social, etc...).

2455

OVERLOAD (Information input)^{2) - 4)}

A cross-level study on this subject was published in 1960 by J. MILLER, who extracted from it an "Information input overload" concept that he states as follow:

"As the information input to a single **channel** of a **living system** - measured in **bits per second** - increases, the information **output** - measured similarly - increases almost identically at first but gradually falls behind as it approaches a certain **output rate**, the **channel capacity**, which cannot be exceeded in the **channel**. The **output** then levels off at that **rate**, and finally, as the information input **rate** continues to go up, the **output** decreases gradually toward zero as **breakdown** or the confusional **state** occurs under overload" (1986, p.77).

Experiences were pursued at five different levels: the **cell**, **organ**, **organism**, **group** and **organization**. As a result: "Data from the five biological and social **levels** yielded information **input-output** curves, the similar shape of which - a cross-level formal **identity** - confirmed the hypothesis." (ibid).

→ **Christmas tree effect; Information overload**

2456

OVERSHOOTING^{1) - 2)}

A **process** which tends to send the system outside of its **dynamic stability limits**.

Overshooting is generally a result of **time lags** in the system's **responses**. It may destroy the system if not controlled in due time. Moreover this **control** is difficult and, in some cases downright counter-intuitive.

This **process** has been very well described in J. FORRESTER's **Systems dynamics**.

The subject is of utmost importance for **governance** in pursuit of a sustainable **management of human systems**.

2457

OVERSIGHT¹⁾³⁾

An unintentional and generally inadvertent omission or mistake

M. MULEJ observes that the **reduccionist** view of issues leads frequently to a **variety** of intricate and unexpected consequences, that may introduce new **issues**, many times difficult by themselves (1991, p.316-17).

Only by applying good criteria to determine the **interdependence** of **causes**, conditions and consequences can oversights be avoided.

MULEJ also underlines the necessity to guard oneself against superficial use of pseudo-system thinking, as for example:

- mastering fictitious **wholes**, but no factual **wholes**
- thinking "**holistic**", but behaving and acting "fragmented"
- use simple-sided ("**tunnel vision**") or merely dialectical **understanding** and enclose oneself unwittingly into such views
- dividing conceptual labor instead of **net-working**

According to MULEJ, problems at the planetary level, for instance, are objects of "Conferences... arranged by the United Nations and make good conclusions, but **actions** are blocked by single-sided, tunnel vision kinds of interests" (p.326)

In conclusion, MULEJ proposes an "ethics of **interdependence**"

2458

OVERSTOCKING^{1) - 2)}

The existence of a number of **elements** or users of a system such as the **resources** of the same become strained and eventually used up.

Overstocking is a frequent **systemic pathology**. It is one of the characteristic forms of **environmental abuse** described for instance in G. HARDIN's "**Tragedy of Commons**".

Overstocking is an insidious **phenomenon**, that people remain unaware of, until very dangerous **thresholds** are approached... or crossed. Many **processes** of this type are currently on the march in **ecosystems**, **economics**, uses of natural **resources**, etc...

P

2459

P.E.R.T. (Program evaluation and review techniques)⁵⁾

An **array** of **systems analysis** techniques used to order, monitor and control projects, using **network analysis**.

An example is the **critical path method** for determination of the optimal chronological sequential ordering of tasks, or when needed, the definition of acceptable alternatives.

2460

PANACEA²⁾⁴⁾

"A simple-and simple minded-**solution** for a problem" (adapted from R.L. ACKOFF, 2001, p. 9)

So-called "recipes", "**magic bullets**" or "quick fixes" are all panaceas.

Good examples of panaceas are:

- Political slogans and unsubstantial generalities about "problems" in **education**, public health, security, **development**, etc., without any serious study of the obstacles, and of practical means to overcome them without creating **side effects**.
- Theories about **management**- as for example "re-engineering", "outsourcing", "downsizing", "organizational learning"- that could be useful only if applied thoughtfully to really well-understood and significant **issues** and specific cases.

Generally much simplifying and out of **context** panaceas are of scant value for addressing practical cases. They could be useful only if applied in an adaptive and readaptive way to a well studied issue or **situation** and with the well organized help from all the **stakeholders**.

Even so, there is an absolute need for a cyclically reiterative consideration of results and **revalidation** of our general **model** as a good **representation** of the issue and of our own **understanding** about what we are trying to achieve, and in which way.

On the contrary "panaceas are about doing things right, not doing the right things" (Ibid, p. 9)

In fact, the "panacea" problem cannot be avoided until we make ourselves able to distinguish what are the "right things" to do. WARFIELD's **generic design methodology** offers practical ways for avoiding **underconceptualization** and misunderstanding (brought about for ex. by **clanthink**, **groupthink**, **blindspots**, etc.) LINSTONE and MITROFF's "**unbounded systems thinking**" is also very useful, as well as CHECKLAND's **soft systems methodology** and the **critical systems thinking** offered by JACKSON, FLOOD and their Hull and Humber-side colleagues.

In short, a naive **belief** in panaceas results from a lack of critical understanding, mainly of one's own implicit illusions. Ackoff's final comment is that the market for panaceas "the weak sisters of fundamentalism" is still very large" (Ibid)

2461

PANDEMIC¹⁾⁴⁾⁵⁾

A worldwide **epidemic process**. This kind of processes is unfrequent, even at a historical scale, and luckily so because they are frightfully destructive. Historical examples are the "Black death" plague (1347-52), the rinderpest in East Africa (in the 1890's) and the so-called "spanish influenza" (1918-19)

Some religious conflicts (in Europe during the 17th century, or ideological **propagation** processes (fascism and communism in the 20th century) seem also to have been of pandemic extension.

2462

PANORAMA OF UNDERSTANDING¹⁾²⁾

H.. BENKING proposes a three-fold space-time panorama of understanding linking subjects, **objects** and **contexts**. He writes "The objective is to transcend and transform by thinking within, between and beyond, not inside "boxes" or domains"

Graphically, Benking proposes a representation through interconnexions between three boxes: the subject-box, the object-box and the context-box.

He writes: "The subject-box and the context-box are looking at the objects in the object-box, and the context-box enables us to map the **metaphors** of understanding the kind of reality in which this is taking place"

Each "box" is represented by a cube, that can easily be subdivided in more elemental sub-boxes corresponding to more specific **situations**.

This model is based, according to BENKING "on the **ekistic** grid, as conceived by DOXIADIS in the field of planning sciences. We can search not only for words, but for "areas" or "bodies" of **data** and **knowledge**. After agreement on **location** and content, genuine capabilities of man can come into play, which allow fast visual access and assimilation of very large volumes of data"

2463

PANORAMA THINKING¹⁾²⁾

H. BENKING considers that "We have to be able to talk about the same things with words which are grounded... We need to see terms and **concepts** in their **context**" ...

and "We can construct **frames-of-reference** as a **schemata** to visually reference and share diverse but inter-connected positions, focuses, ranges and horizons, in order to develop not

only common grounds but a tolerance for alternate ways of seeing our different **levels** and **scopes**"

By adequate and open **conversation**, we can create a common ground. In this way every player can discover his own place in the general panorama and understand better what he does and what he could and should do, or not do.

Benking advocates the construction of a good representation of the panorama (**Eco-cube/know map**)

We can use the cybernetic **tools** to order our **data-base**. But he warns that we should not let us stray in a "virtual **cyberspace**" in a mainly and merely technical sense, with no **relevance** to real **situations**.

Scales and proportions and their consequences should be duly taken into account in our representation, as we construct a 3 dimensional space/time **model**.

→ **Multiperspectivism**

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PARADIGM³⁾

A **meaning** system delineating relevance and nature of **data**, increments of measure, **criteria** of proof and **inference rules** (W. ACAR, 1988, p.121).

E. SCHWARZ goes even farther and defines it as "The **set** of the traits characterizing an **interaction mode** with the world" (1993, p.10). For him a paradigm also defines ways of **perception** and is closely related to culture. From an **epistemological** perspective it would be a "**semantic attractor**", acting as a **constraint** and, at the same time, as a stimulating factor. Finally, the paradigm also influences the way tools are made and used. An example could be the opposition between hypertechnical medicine and so-called natural-**holistic** one.

A paradigm thus becomes the reflection of a **Weltanschauung** (**world view**) and the invisible **pattern** that guides the construction of **theories**, **methodologies**... and even beliefs, justified or not by reasoning.

ACAR cites and discuss the different **meanings** given to the term by T. KUHN:

"... in much of the book the term "paradigm" is used in two different senses. On the one hand, it stands for the entire constellation of beliefs, **values**, techniques, and so on, shared by the members of a given **community**. On the other, it denotes one sort of **element** in that constellation, the concrete puzzle-solutions which, emphasized as **models** or examples, can replace explicit **rules** as a basis for the solution of the remaining puzzles of normal science" (1970, p.175).

Writes ACAR: "The first is, according to KUHN, an overall *sociological* sense, while the second is a more *technical* one which corresponds to the traditions and **criteria** that, in every **domain** of **inquiry**, distinguish "normal" from "heretical" science as well as define traditional disciplinary **boundaries**" (p.121).

ACAR cites P. SHRIVASTAVA and I. MITROFF, who write: "Paradigm guide the conduct of **inquiry** by defining legitimate research questions in a field, describing appropriate **methods** for addressing these questions, outlining the broad scope of an **inquiry** and encapsulating a researcher's assumptions in **inquiry**" (1984, p.18).

According to G.J. DALENOORT a paradigm "implies a set of beliefs, starting positions, **methodology**, and an **epistemology**, all concerning the **knowledge** making up a scientific discipline, that determine how one ought to interpret the **facts** of that discipline. Paradigm may even differ in their position as to what are the **facts**, and what the interpretations" (1989, p.1).

Science as it is made – under the **control** of some scientific establishment – is practically limited and in some cases repressed in the sense of KUHN or ACAR. But as many aspects of paradigms are **consensual**, they are intrinsically transient. However, the bedrock **rules** of **scientific method** constitute a quite immutable fundamental paradigm whose prescriptions cannot be ignored.

As to the system concept, it is possibly a new paradigm, but *it does not replace* the so called **reductionist** paradigm, *it merely complements* it, or reframes it.

D. BOHM and F. D. PEAT state: "Paradigms include not only systems of theories, principles, and doctrines, but also what we have called the "tacit infrastructure of ideas", which are transmitted to later generations of scientists in a kind of apprenticeship" (1987, p.26).

A paradigm presents thus a conscious proposal, but also a **set** of unconscious **constraints** on thought, which is the reason why, in the long run, it finally blocks **creativity** (i.e., when the productivity **limits** of the paradigm have been attained).

According to E. GUBA (1990), any paradigm can be characterized by three complementary **criteria**.

The first one is **ontologic**: it implies a basic stand about the correspondence with the postulated reality of the **knowledge** that can be acquired.

The second one is **epistemologic** and states the nature of the relation between **knowledge** and the knower.

The third one is **methodological** and defines the ways considered correct to further research.

None of these **criteria** can ever be definitively confirmed in any absolute sense. This explains why former paradigms are abandoned and new ones adopted.

J.van GIGCH examines in the following terms the justifications for the existence and uses of a paradigm: "A discipline, as well as the theory(ies) which constitutes a discipline need a paradigm for the following reasons:

1. A paradigm constitutes the "essence" of the discipline.
2. A paradigm constitutes the "world view" of its adherents.
3. Scientists in the discipline use the statement of the paradigm to establish the problems which it has to solve (KUHN, 1970).
4. The scientific establishment works usually in the direction of the prevailing paradigm, i.e., its **rules** and procedures are directed by the currently accepted paradigm (KUHN, 1970).
5. The paradigm is directly implicated in the **design** of the instruments, apparatus and **methodologies** used to solve the problems of the discipline (KUHN, 1970).
6. A paradigm is essential to discover (a) "anomalies" (KUHN, 1970) and (b) "dilemmas" (van GIGCH, 1993, p.42).

The same author, with J.L.LE MOIGNE, (1989, p.132) proceeds by examining the questions which a paradigm must answer and enumerates the following:

- "1. What are the main sources of knowledge of the discipline?
2. What constitutes the object of study of the discipline?
3. What are the main schools of thought underlying the discipline?
4. What are the main purposes of the discipline?
5. What are the significant instrumentalities (methodologies) used by the discipline and, by derivation, its main activities?
6. What are the anomalies and unresolved problems which are facing the discipline?

"Paradigms influence the **epistemology** of the **inquiring systems** over which they dominate and, in turn, the view of reality which emanates from these systems. Paradigms can be compared on the basis of the following headings:

- a) Description of the field,
- b) Nature of the **domain**,
- c) Problems to which suited,
- d) Applications of the paradigm,
- e) Nature of the solution (or of the "truth" obtained),
- f) **Criteria** used to evaluate "truth", and
- g) Proof and guarantor of "truth"

Finally, van GIGCH concludes: "We distinguish a paradigm from a **methodology** by indication that the paradigm is usually "content" or "substance-free", in the sense that it applies to many problems in the **domain** regardless of

their specific **content**, whereas a **methodology** is a problem-oriented procedure or approach which incorporates a particular paradigm" (Ibid., p.43-44).

This is why G. KLIR refers himself to *methodological paradigms*, based on "a particular **set** of assumptions, upon which different **methods** may be based... Each assumption contained in a methodological paradigm restricts the applicability of the associated **methods** and, consequently, restricts the **set** of possible solutions in some specific way" (1993, p.40). This explains, for instance, the frequently postulated *exclusive* complementarity between the **reductionist** and the **holistic**-systemic paradigms.

It should be noted that, before KUHN's book, "paradigm" had merely the meaning of "example". On the contrary, in the recent years, it has been uncorrectly popularized and used in many abusive ways.

For an interesting general evaluation of the impact of KUHN's work between 1962 and 1990, see J. HORGAN (1991).

E. MORIN observes: "A paradigm is unconscious, but irrigates conscious thinking and controls it". It can also thus be said that it is "supraconscious" (1999b, p. 26)

The dominant paradigm in a society determines a characteristic cultural **imprinting** (p. 27). The paradigm makes some aspects quite visible, but obscures or suppresses others.

2465

PARADIGM (Cartesian) ¹⁾³⁾

E. MORIN describes as follows the main characteristics of the paradigm derived from R. DESCARTES (1596-1650) philosophy and which dominated western thought from the 17th Century on.

"The Cartesian paradigm separates the "subject" from the "object", with a proper sphere for each: philosophy and reflexive investigation on one side; science and objective research on the other side" (1996, p. 26); **dichotomy**, and it emphasizes also the origin of growing and finally extreme specialization.

MORIN enumerates the following paradigmatic dichotomies in DESCARTES' worldview: "**subject/object**; soul/body ; spirit/matter; quality/quantity; **causality/ finality**; feeling/reason; **freedom/determinism**; existence/essence" (Ibid.).

2466

PARADIGM (Social) ¹⁾³⁾⁴⁾

A constellation of concepts, values, perceptions and practices shared by a community, which forms a particular vision of reality that is the basis of the way the community organizes itself (F. CAPRA, 1977, p. 6)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Capra observes: "...twenty five years after KUHN's analysis, we recognize the paradigm shift in physics as an integral part of a much larger cultural transformation.

The intellectual crisis of the quantum physicists in the 1920's is mirrored today by a similar, but much broader cultural crisis" (p. 5).

According to Capra it is the mechanistic paradigm which is receding. This is obviously true. But this mechanicism had deeper and older roots in Western societies and is probably based on the paternalist and authoritarian God-driven worldview which still rules partially in Mediterranean societies.

Cultural anthropology and colonial dominance in the rest of the world slowly eroded this traditional cultural type through trans-cultural feedbacks. Moreover, while cybernetics is still in a sense mechanistic, organismic biology and its offspring, BERTALANFFY's original systems theory, as well as Gestalt psychology and more recently autopoiesis derived from von FÖRSTER 2nd order cybernetics are also prime movers of the paradigmatic shift.

In any case, no society can maintain its coherence and general activity without some basic social paradigm. In most of the cases this paradigm is basically expressed by some fundamental religious belief. During the 19th and 20th centuries some political or social ideologies tended to replace religious faith as social regulators. These substitutes have generally been short-sighted and short-lived.

→ **Autopoiesis; Non-no; Non-aristotelician thinking; Non-identity principle; Non-identity; Non-principles; Semantics (general); Synechism**

2467

PARADOX³⁾

A self-contradictory statement or argument.

The sorting out of paradoxes – which reflect a logical and semantic pathology – has been one of the roots of von FÖRSTER, MATURANA and VARELA's **cybernetics of 2nd order**. It had formerly led to RUSSELL and WHITEHEAD's critique of the fundamentals of logic and to BATESON's study of double-bind pathological situations.

Systemic models and concepts owe much to the study of the paradoxes pathology, as there was a basic need for a correct ordering of complexity levels in systems.

2468

PARALLEL DISTRIBUTED PROCESSING (PDP)^{1) - 4) - 5)}

PDP are softwares for use in parallel computers. They emulate neural networks in the brain and are used to "train" nets in these computers to construct representations of specific situations

RUMELHART enumerates the major aspects of a parallel distributed processing model as follows:

- a set of processing units ("neurons")
- a state of activation y_i for every unit, that determines the output of the unit
- connections between the units. Each connection is defined by a weight w_{ij} , which determines the effect of the signal of unit i on unit j
- a propagation rule (a governing equation), which determines the effective input u_i of a unit from its external inputs
- an activation function F which determines the new level of activation based on the effective output $u_i(t)$ and the current state $y_i(t)$
- an external input or offset θ_i for each unit
- a method for information gathering
- an environment within which the system must operate, providing input signals and – if necessary – error signals

(J. Mc CLELLAND & D. RUMELHART: "Parallel Distributed Processing Explorations in the Microstructure of Cognition" 1986).

This is the basic connectionist interpretation of the brain as the massively parallel computer, which depends on the general and local architecture of the connections between elements and on the dynamics of synaptic weights adjustments.

R. FISCHER explains PDP, applied both to artificial and natural intelligence, as follows: "In this... parallel distributed processing approach, learning takes place through changes in the system itself" (1992, p.208).

This comment seems to establish limits to the organizational closure concept: Before closure, organization must be constructed (but probably on the base of organizational closure already acquired at a lesser level of complexity, biological at least).

FISCHER adds: "The principle of PDP implies that activities of ordered sets of nerve cells can be considered to be mathematical vectors. An important aspect of this vector approach is that it focuses on the explanation of brain functions in terms of neural networks, i.e. mass action and that it is, therefore, compatible with the modular organization of the brain... The complexity of the neural circuitry of the cerebral cortex can be looked upon as a neural correlate of intelligence" (p.221).

FISCHER even observes: "At the interface of human mind functions and A.I. lurks the thought that the mind is trying to create intelligent systems in its own image" (p.226).

M. BODEN applied the PDP models to the activity of a group of children: "The class-decision is due to the parallel processing (all the children chatter simultaneously) of localized computation (each child speaks to, and is di-

rectly influenced by, only her immediate neighbours) and is distributed across the whole community (as an internally consistent set of mini-decisions made by all the children).

In PDP models, concepts are represented as activity-patterns across a group of units (Children)" (1990, p.121).

2469

PARALLELISM¹⁾²⁾

The simultaneous transformations of many relationships among many elements within a system.

Such a situation implies the existence of a significant number of coexisting processes and, as a consequence a certain leeway in the behavior of the system as a whole. It is however important to understand that the very concept of system implies also a global general – but not absolutely constraining – coherence.

Parallelism is altogether the condition for adaptive variation because it reflects a relative autonomy in space and time of different local behavioral lines in the system.

J. HOLLAND defines parallelism as the "concurrent activity of many rules" (1992, p.174) and describes it as a fundamental characteristic of what he calls "classifiers", which are in fact all adaptive and evolutive complex systems, i.e. not the simple monocausal processes. Examples of this type of systems can be ecosystems, the human brain, automata endowed with adaptive behavior.

He comments: "Parallelism makes it possible for the system to combine rules into clusters that model the environment, providing two important advantages:

"1. **Combinatorics** work for the system instead of against it. The system builds a "picture" of the situation from parts, rather than treating it as a monolithic whole...

"2. **Experience** can be transferred to novel situations, such as a "red car on the side of the road with a flat tire", the system activates several relevant rules, such as those for "red", "car", "flat tire", etc.

"When "building-block" rules, such as those for "car", have proved useful in past combinations, it is at least plausible that they will prove useful in new similar combinations. To exploit these possibilities, the rules must be organized in a way that permits clusters of rules to be activated in changing combinations. Building-block rules then give the system a capacity for transferring experience to new situations" (Ibid).

The whole of HOLLAND's book is dedicated to explain in detail how such rules work in natural systems and how they could be introduced in complex artificial systems. This last field is now in full development (f. ex. "artificial life" and "genetic algorithms").

HOLLAND distinguishes "intrinsic" parallelism, proper to the system itself, and "implicit" parallelism, as the "implicit" workings of the algorithm (Ibid, p.X).

2470

PARALLELISM (Different types of)^{1) - 2) - 5)}

(What is described hereafter are the various degrees of parallelism that may be conceived for computers. However, these notions seem very valuable for the understanding of *any* parallel **process** in very **complex systems**, as for example the **brain** or human societies).

"**Replicative parallelism**... Each **transputer**... replicate and execute the same **code**, but on a different **set of data**. This form of independent parallelism (the **processes** do not communicate much) is quite trivial" (T. MUNTEAN, 1988, p.1319). Indeed, this is practically a "multi-sequentiality".

"**Geometric parallelism**: or "**data structure oriented**" maintains more or less the same **code**, carried out by each **processor** endowed with the responsibility of one **data subset** only... The price to be paid for geometrical **optimization** of a **data** in a **machine** is an extensive **communication**. Indeed local computing in an area may obtain **data resulting** from computing in nearby areas or on farther away **processors**" (Ibid.).

The word "resulting" shows that this is organized sequentially from multiple **simultaneities**, defined by a "Principle of **locality**", as it is called by the author.

"**Algorithmic parallelism**: Each **transputer** carries out only a small part of the **algorithm** or **program**. And the **data** cross the **net** from **transputer to transputer (data flow)**. The **communication** between **processors** must be elaborated and efficient and the work load must be correctly distributed" (Ibid.).

Obviously, in this last case, **communication** must be constrained by the **algorithm** to obtain a **net** sufficiently organized to be coherent and yet, not totally overconnected. It remains to be seen if it would be feasible to create **self-organizing algorithms**, able to develop themselves from some initial **configuration**, using the **interactions** between the system and its **environment** for internal **learning**.

2471

PARAMETER²⁾

"Any of the numerical constants which appears in a mathematical expression of **relationships** among **variables**" (T.F.H. ALLEN & T.B. STARR, 1982, p.275).

or

"A **variable** or an arbitrary constant appearing in a mathematical expression, each value of which restrict or determines the specific form of the expression" (American Heritage Dictionary, p.951).

or

"The **input** to a system which determines its **mode of operation** and thus defines what kind it is" (K. KRIPPENDORFF, 1986, p.57).

In a more general, but less precise sense: a determining factor.

This is what ASHBY expresses in the following way: "Given a system, a **variable** not included in it is a **parameter**" (1960, p.71).

2472

PARAMETER (SYSTEM)^{1) - 2)}

"A system property which has a universal **domain** of application, i.e. which can be ascribed to any system" (I.V. BLAUBERG, V.N. SADOVSKY and E.G. YUDIN, 1977, p.184).

These authors adopt this term forged by A. UYEMOV and give the following examples of system parameters:

"A system is **autoregenerative in elements**... if it is capable of regenerating its **elements** in the **process** of functioning.

...and it is **autoregenerative in relations** (or relation autoregenerative)... if it is capable of restoring **relations between elements**" (Ibid).

These two system parameters have, jointly, the same **meaning** as MATURANA and VARELA's **autopoiesis**.

The authors add: "If a system is capable of regenerating its **elements** or **relations** under the effect of other systems it is called **externally regenerative in elements** (externally determined **element** regenerative)... or **externally regenerative in relation** (externally determined **relation** regenerative).

"The system is **immanent**..., if the **set of elements** and the **set** of correlates of the system forming **relation** coincide.

"If the system is destroyed when a single **element** is eliminated it is called **minimal**...

"Systems preserving their **identity** under structural **changes** are **structurally stable**" (Ibid).

This list of systems parameters can be much extended. The notion seems close to the concept of **isomorphy**.

2473

PARASITISM¹⁾

Condition of a system which requires **energy** and/or **information** from a host system from which it depends totally for its **survival**, without any benefit for its host.

Ectoparasites perforates the **boundary subsystem** of their host, fixing themselves on the outer side of the **boundary**. Endoparasites introduce themselves into some inner **subsystem** of their host.

The parasite differs from the **symbiont** or the **commensal**, which are beneficial or neutral for their hosts.

A. RAPOPORT comments: "As a rule, parasites introduced from the outside can be combated by the immunological **reactions** of the host against the biochemically 'foreign' invaders.... In general, *successful* parasitism depends on a **simulation** by the parasite of characteristics that the host 'recognizes' (mistakenly) as its own" (1969, p.25).

Parasitism also can be social, as seen by numerous examples in insect societies... and possibly in human ones, where some **groups** live off the social production without retribution in any visible way.

In parasitic **situations**, "what one **group** gains is what another **group** loses", as stated by MARUYAMA, who considers this a **zero-sum game**. This author describes also **symbiosis** as a **positive-sum game** and mutual destruction (mutual "**antibiosis**"), a **negative-sum game** (1976, p.204).

However, in many cases this is merely a transient **situation**, as when the parasite destroys or kills the host, bringing about its own elimination. Parasites escape from this fate only if their parasitic **state** is permanently tolerable for the host, or if they are a **phase** of a **cycle** affecting successively various hosts, or if they have a life **cycle** with a **phase** of **autonomous** life.

Recently C. ZIMMER gave a number of examples where apparently strict parasitism can be useful for the host in some quite covert and unexpected way.

He also observed that some parasites are able to subtly manipulate their host's **behavior** for their own ends (2000 and M. RIDLEY's review, 2000, p.48-9).

In both situations, parasitism fosters **adaptation** and, in ZIMMER's view, even probably **evolution**. It would be interesting to find out more about this **mechanism**, even possibly between **groups** in human societies.

2474

PARETO's PRINCIPLE¹⁾²⁾⁵⁾

A **rule** according to which 20% of the people concentrate 80% of the **resources**, or income.

Similar types of **ratios** are known, as for example **Zipf's Law**, which says that in a sufficiently large collection of **elements** (as for instance the words in a book) the second most numerous item will occur about half as often as the most common, and so on in an inverse ratio: 3rd / one third, 4th / one fourth, etc.

Pareto's Principle seems thus closely related to **power laws** and **order parameters** (HAKEN) and to WEIERSTRASS **renormalization function**, which defines an inverse relation between **frequencies** and **amplitudes**. Such inversely proportional relations appear in a number of natural **phenomena** (earthquakes, hurricanes) or economic ones (markets fluctuations and crashes).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Similar **complementary ratios** are showing now in the electronic world web, where some few sites have many pages when most others have quite few. The same relation seems to exist among a few much visited sites and many rarely visited ones.

Thus Weierstrass, Pareto, Zipf, Haken and probably others have discovered the same basic **model** under different guises. The status of the model is clearly systemic in its most general **isomorphic form**, which is probably a generalized power law or its mathematical expression as the renormalization function.

→ **Self-similarity**

2475

PARRONDO's Paradox ²⁾

According to PARRONDO's paradox, it is possible to win at two loosing **games** by switching from one to the other

(It is a kind of jumping from one position to the other by exploiting the **random** movement of the **elements** in the game, similar to **randomness** in **Brownian motion**)

In the opinion of the physicist P. DAVIS and E. KLARREICH, the paradox could have significant implications related to the origins of life

2476

PARSIMONY (Law of)

→ **Occam's Razor**

2477

PARSIMONY (Requisite) ^{2) - 3)}

The necessity to avoid that "the **rate of flow of information** to the designer... exceed processing capacity" (J. WARFIELD, 1995, p.126)

WARFIELD even enounces a "Law of **requisite parsimony**", related to the fact that "Every individual's **short term brain activity** lends itself to dealing **simultaneously** with approximately seven items (a number that is reached with three basic items and four of their joint **interactions**)" (p.125).

If the law is not respected, **overload** sets in, and some **data** are not registered or **interactions** not perceived.

WARFIELD comments: "If the law of requisite parsimony is being unknowingly violated, one would expect that the impact would be revealed in the failure of large systems **design**. This is precisely what is being observed all around the world" (p.126).

The subject is related to the problems posed by **aggregation** and **underconceptualization**. Satisfying simplification through **aggregation** is more easily obtained through systemic **models**, out of which good **criteria** about **levels of interactions** can be obtained.

→ **"Algorithmic compression"** (as a possible tool for parsimony)

2478

PART ¹⁾

Any connected **element** in a system.

A part is a **whole** in itself *plus* its **connections** with other parts and *less* the **constraints** that result from these **connections**. This implies that its **identity** is somehow modified in a "social" sense and that a part severed from the **whole** for study is not the same thing when integrated in the system

In a **complex system** there may exist parts made of subparts, at different **levels**. We better should call the former, **subsystems**.

Any part has a specific **functional** value and a **positional value**.

As they are generally integrated within **subsystems**, they are mostly *locally* interconnected. However, in some cases a part can be connected with different **subsystems**, in most cases in an on-off way, or through oriented or polarized subparts.

2479

PARTICIPATION ⁴⁾

The active involvement of – if possible – all the **stakeholders** in the **design** and **management** of the system they are **parts** of.

M.E. DODDS and G. JAROS write: "Specialized **hierarchies** with separation of authority and responsibility have lost their **effectiveness** and **efficiency**".

This is a result of the evermore intricate character of great modern **organizations**, in which no one can anymore know every important aspect, nor even clearly see why some aspects are relevant.

On the other hand, **stakeholders** are becoming, by need, evermore qualified, reflexive, and even sophisticated.

DODDS and JAROS conclude: "... over the past decades we have learned that one cannot develop others, although one can facilitate their self-development. Managers are beginning to learn, and politicians are hopefully soon to learn, that one also cannot *control* others anymore... Empowerment of people and empowerment of nature are both required" (1994).

These new features in **sociosystems** explain the emergence of new ways to manage **problems** and design systems.

→ **Design conversation, Generic Design, Heterarchy, Problem.**

2480

PARTIPOTENTIALITY ²⁾

The character of "a **living system** which does not itself carry out all **critical subsystem processes**" J.G. MILLER, 1978, p.18).

"A partipotent system must interact with other systems that can carry out the **processes** which it does not, or it will not survive. To supply the missing **processes**, partipotent systems must be **parasitic** on, or **symbiotic** with other **living** or nonliving **systems**" (p.18-9).

The evolution of numerous individuals toward a growing degree of **symbiosis** could be considered as a significant step toward **sociality**, i.e. to the **emergence** of a system integrated on a higher level of **complexity**.

2481

PARTITION ²⁾

The division in **subsets** of the **model** of a system.

St. BEER writes: "Obviously **sets** can have **subsets**. The commonest form of partition in ordinary life, and particularly in the company **organization**, is to define a **set** of **subsets** which exhaust the **set** and do not overlap" (1968, p.106).

This may be needed in order to construct a manageable **model** of the system. We should however remember that no-overlapping is fictional: without overlaps, the system would not be connected, and so, would not be a system at all. An uncomfortable result of this is pointed out by M.C.LE DUC: "To date, nobody has conceived a general, teachable and explicit method for partitioning problems. Most scientific papers do not articulate how and why a particular partition, and not another, has been chosen. **Analysis** is an intuitive **process** that a competent scientist has learnt by experience. The worst result of this precept is that many take the **part** for the **whole**... Just walk into an hospital or a university" (1992, p.919).

A. EDWARDS fractalization of **VENN diagrams** seems to open a way to partition without loss of **connections** (1989).

2482

PARTITIONING ^{2) - 4)}

The progressive formation of specialized **subsystems** in a **self-organizing** system.

This seems to be a very general systemic **process**, from stellar systems to **ecosystems** and **living systems**, and social ones (social insects, enterprises, **organizations** and bureaucracies).

It could be related to LOTKA's "world engine" and, from another viewpoint to KAUFFMAN's "frozen cores".

2483

PATCHINESS ^{1) - 2)}

The character of an irregularly checkered **environment**.

Patchiness results of **disturbances** which impair or destroy in a more or less **random** way **parts** of a natural or artificial **environment**. The general result is a differentiated

mosaic. Once in existence, "...patches have differential susceptibility to a unit of **disturbance**" (S.R. REICE, 1994, p.431). There are thus **feedbacks** between **disturbances** and patches. This allows for possible **evolution** of the **environment** and variable impacts on the systems interacting within it.

2484

PATH

→ Graph

2485

PATH DEPENDENCE¹⁾⁴⁾

The way future **events** and **behavior** become oriented by former events or **decisions**.

Some of these may even have been accidental or defined by **random choice**.

Interesting historical examples are the accounting technique, the metric system, the progressively universal use of some technical innovations as for ex. traffic lights, including their color **code**; and the generalization of similar **ideographic signs** in airports and railway stations.

This is a logical result of system design oriented toward economy of **resources** and **reduction** of **redundant learning**.

→ Ideograms

2486

PATHOLOGY of complex systems^{1) - 2) - 4)}

The study of global disfunctions in systems, as well as of **disturbances** in the **interconnections** between **subsystems**.

The traditional **reductionist** attitude leads to a dismembered view of systemic **symptoms**. However, illness is not always so much as of an **organ**, or an individual, or a group, but as of their **interrelations** with other **organs** or individuals or **groups**, at the same or at different **levels**. Thus systemic pathology should study **communications** problems, at their physiological, technical and/or **informational levels**; **regulators** and **controls** malfunctions; global **governance** problems; etc...

H. SELYE research on **stress** was a partial, but important step in this direction. In such way a general pathology of **complex systems** could be constructed. (Ch. FRANÇOIS, 1984). Important applications in **management**, economy and social sciences would then be conceivable.

Among the most important systemic pathologies we can list the following:

- Progressive disorganization of internal **communication lines** in the system, leading to loss of **coherence** and capacity of **reaction** due to insufficient or delayed **information**;
- Internal **overcrowding** or **overstocking** of the system, leading to exhaustion of vital **resources** and progressive destruction of the system;

- Asphyxia of the system due to the sudden or progressive curtailment of needed **energy**, **matter** and/or **information inputs**, caused either by **changes** within the environment or internal **malfunction**.

- Overtaxing of **environmental resources** or capacity to absorb **outputs** (either useful or wasteful);

- Confusion in **coding** and **decoding**, leading to progressive loss of the capacity for meaningful **interactions** among the **subsystems** or members of the system;

- Loss of **adaptive** capacity, characteristic of **ageing processes**;

- Unbalance or downright incompatibility between simultaneous or sequential **goals** (for example between local and global, or **short** and **long term** ones);

- Misunderstanding of natural **regulations** or use of ill-conceived **controls**.

Many more aspects of systemic pathology could probably be discovered and usefully researched.

→ Diagnosis

2487

PATRIMONIAL ACCOUNTING⁴⁾

A still unexistent accounting **method** that should keep account of used-up **resources**.

The absence of any **method** to account for the disappearance of non-renewable, or very slowly renewable **ecosystems resources** is a glaring gap in general economy accounting, which states only actives and forgets passives.

This is merely the nonsystemic accounting of plunder. It maintains a false **assessment** and **understanding** of the supposed **development process**, because it does not enter in the books the price future generations will have to pay for the renewal of used-up **resources**, or even their definitive or very long-term loss, which possibly will render unsustainable our present standard of life (even where it is still miserable).

W.D. GROSSMANN and K.E.F. WATT observe: "Financial accounting is misleading when hidden **costs** (to the public, to **resources**, to future generations and to **ecological systems**) are not calculated. The most striking example is the calculation of gross national product. For example GNP increases if **ecosystems** are damaged and afterwards repaired" (1992, p.21). Also the British economist E. MISHAN has given startling examples of the same evaluation procedure, which in GROSSMANN and WATT's words: "is a formula for destroying the planet as quickly as is economically profitable (as) it discourages any kind of savings, investment, or husbanding of planetary **resources** for which the pay-off would appear largely in a distant future. This means that societal **decision-making** is being run off a theory which at its roots guarantees ultimate destruction of most planetary **resources**". The authors suggest:

"One way around this is to measure all present investments, and future overheads and gross profits in units of **matter** or **energy**, for which interest and inflation rates are irrelevant in their present form" (Ibid). The American economist D. PIMENTEL has made similar comments on the illusions about agriculture's productivity when direct and indirect **inputs** of **energy** are not taken into account.

Economists should invent systemic accounting!

2488

PATTERN^{1) - 2) - 3)}

"...an aggregate of events or objects which will permit in some degree... guesses when the entire **aggregate** is not available for inspection" (G. BATESON, 1973, p.383).

The "**aggregate**" must be somehow **ordered**, i.e. have some systemics characteristics, because no pattern is possible without more or less regular **interrelations** between these **events** or **objects**. Or at least, some **interrelations** must be postulated by our **brain**, which does not necessarily means that they are a very good **map** of reality. Copernican and Newtonian cosmical patterns were more accurate than Ptolemaic ones, and Einsteinian ones still better.

E. LASZLO states that "... **structures** are pattern-conserving and... innovations, as well as external **disturbances** are pattern-transforming" (1974, p.35).

2489

PATTERN AS A METAPHOR^{2) - 3)}

T. VAMOS et al. state that patterns have generally the character of a metaphor: "...**sets** of coherent **data** (that) are stored as learnt devices for **survival**" (1992, p.1609).

They add: "The pattern metaphor as an external view of **knowledge representation**, i.e. a self-reflective **representation** of the mental **representation** is a natural development (of the entire phylogenic **evolution** of living creatures)" (Ibid).

A very good example of metaphoric pattern is our grouping of stars that are generally without any relation whatsoever into "constellations". These groupings have many practical uses, but their unity is a mere perceptive illusion, that is even different from culture to culture: Chinese constellations for example, are different from the Western ones.

2490

PATTERN CLOSURE^{3) - 5)}

The ability of the **brain** to contrive the illusion of complete visual, auditive or tactile **perception** from an incomplete one.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

K. SAYRE explains: "If a pattern is particularly well established within the **subject's** perceptual **repertoire**, **simulation** of a **subset** of its operating sequences may engage the entire **set** of **information-processing activity**" (1976, p.158).

Shifting pattern closure is responsible for **figure-ground** or figure-figure reversals as for instance in the famous old-woman, or young lady picture. Pattern closure is closely related to **Gestalt perception** and, generally **organizational closure** in the perceiving observer.

2491

PATTERN COMPLETION ¹⁾⁵⁾

"The ability to fill in missing or incomplete patterns so that the entire pattern is perceived rather than a partial pattern" (M. CAUDILL, 1992, p.48).

2492

PATTERN DIVERSITY in SPACE OCCUPATION ²⁾

The extent to which living **organisms** of the same species organize themselves spatially (J. SIRGY & R. GILES Jr., 1986, p.236).

These patterns can be "solitary, clumped, **random** and uniform. These are all spatial, but are related in **time**" (p.240).

The "clumps" may be of very varied types. In territorial occupation, they may be geometric, for example, square, **hexagonal** and/or concentric.

They may also be **random**, **clustered** (in very various ways), or regular (also in various ways). The same pattern can reappear at different **scales**, as for example in **fractals**.

They generally organize from simpler patterns and are **time-directed** and **time-binding**.

They appear in territorial **organization** in general.

2493

PATTERN GENERATOR ²⁾

J. COLLINS writes: "Scientists believe that insect locomotion is controlled by a **network** of nerve **cells** called a central pattern generator (CPG), which produces **rhythmic signals**. Pattern generators are also involved in many other forms of **rhythmic behaviour**, including breathing, chewing and sleeping" These CPG, presently a focus of study in insects, could lead to valuable explanations of **behavior** of more complex animals. Mathematicians have taken up the subject and "have found that the best mathematical **models** for CPGs are networks of **coupled oscillators**" (1994, p.36-7)

COLLINS' stimulating paper also connects CPGs with **symmetry-breaking processes**. It would be interesting to investigate and try to pinpoint CPGs in many other "rhythmic" – i.e. **periodic** - **processes**. This could lead to many other systemic conceptual connections.

→ **Dictyostelium discoideum**

2494

PATTERN MAINTENANCE ²⁾

The relative or cyclical **stability** of **interrelations** between **elements** and/or **subsystems** in a system.

Pattern maintenance is a condition for **homeostasis**.

It corresponds to the conservation of functional **efficiency** in social as well as in **living systems**.

Rupture of established patterns implies always a very dangerous **situation**, even when it marks the **transition** toward other types of patterns.

2495

PATTERN MATCHING ⁵⁾

"The capability of correlating an overall pattern of **input signals** of any type with an **output signal** of some arbitrary type" (M. CAUDILL, 1994, p.18).

An example is matching the face of a friend with her/his name.

2496

PATTERN (Meta)

→ **Metapattern**

2497

PATTERN RECOGNITION ^{2) - 3)}

The way a system retraces **structures** and **processes** regularities, becomes able to register them and to use this **information** later on.

Pattern recognition is a very important systemic **function**. It seems to have two different aspects.

First, a pattern must be discovered and identified. This implies the recognition of various coherent steps in a **process**, or of the **coherence** of various **elements** in a **gestalt**. Once the pattern has been identified, the corresponding **information** must be kept.

Once recorded, the pattern can be "re-cognized" when the same **process** or **gestalt** reappears.

Different forms of pattern recognition **processes** are present in immunology, cerebral **activity** (see for ex. **STEINBUCH matrixes**), **artificial intelligence** and social **activity** (for ex. in all types of **languages**, in **stigmergy**).

2498

PATTERN (Rules generated) ²⁾

Practically any kind of complex patterns can be generated by an appropriate **set** of rules, at least in a **structured space**, invariable in **time**.

Rules for creation, **reproduction**, ways of propagation, **survival** and destruction of **elements** are needed.

The idea of rules generated patterns led to J.von NEUMANN **cellular automata**, to J. CONWAY's **game of life** and to M. MARUYAMA **mutual causal (deviation-amplification) models** of systems self-construction.

Generating rules are also fundamental for the development of **networks**.

Some rules generated patterns may become partly or totally stabilized with **time**, i.e. are potential **genetic algorithms**.

2499

PATTERN (Temporal) ²⁾⁴⁾

A sequence of **events** or **actions** characterized by a **configuration** well distinguishable from other configurations and that may be repetitive.

A frequent example are birdsongs. The same bird may repeat many times a typical sequence of notes. Or birds of the same species may transmit a similar song **pattern** from generation to generation.

D. GERNERT recognizes a variety of temporal patterns: "**pattern generation**, pattern transfer, **pattern recognition**, pattern interpretation and pattern application"(2000a , p. 158)

He recognizes such patterns for example in molecular biology and in developmental biology.

It is however obvious that temporal patterns can be observed in many fields under the guise of periodic **processes**, which may even be **self-similar**

→ **Self-similarity in the Weierstrass equation ;Fields within fields within fields; Morphic field**

2500

PATTERNED RELATIONSHIPS ²⁾

The more or less permanent or recurrent **connections** between the **components** of a system (after B. BANATHY, 1973, p. 88).

BANATHY explains: "These **relationships** make up the interactive **functions** that **components** carry out by **design** and that display the **structure** of the system" (Ibid).

This concept is obviously related to MATURANA and VARELA'S **organizational closure**. However, if the system must be designed, then its **organizational closure** should be programmed... if this can be possibly done!

2501

PATTERNING ²⁾

The discovery or ordering of specific and repetitive **interrelations** between associated **elements**.

The discovery of any pattern implies that the associated **elements** are **parts** of a system.

G. BATESON writes: "... patterning or **predictability** of particular **events** within a larger **aggregate of events** is technically called '**redundancy**'" (1973, p.382).

In fact, **predictability** results from the discovery of patterns. Patterning is also a tool for **compression of data**, leading to construction of **algorithms** (see: **Algorithmic incompressibility**). It seems to be a basic ability of the brain.

2502

PATTERNING (Dynamic) ²⁾

"The aggregate **effects of energy flows** which emerge from collective or aggregate **relation in networks**" (V. ROWLAND, 1976, p.121).

This **effect** corresponds to the **synchronization** of interconnected **effects**.

ROWLAND gives the following example: "Electrical generators with their own **governors** vary somewhat around the 60 cycle **frequency**. When connected up in **parallel**, however, those generators running too slow are speeded up and those too fast, slowed down. The combined compensations of the whole **network** produce a very stable 60 cycles per second. However, if these generators are linked up in series they do not stabilize each other in terms of the electrical **feedbacks** inherent in a **parallel** arrangement.

"Thus... the dynamic patterning refers to a stabilizing of a **frequency** which is produced not by the **elements** of the system but rather by the manner in which they are interconnected or related" (Ibid).

The same effect also appears, for example, in ASHBY's **homeostat** and has been shown by KATCHALSKY et al. to exist in brain cells assemblies (Ibid).

It is also present in **ecosystems**.

It is the result of the existence of various **initial conditions**, submitted however to a basic global superseeding **determinism** (See: **chaos**).

Dynamic patterning is a very basic **coherence condition in networks** and **complex systems**, in which it provides a diffuse and distributed, but at the same time, global **control**.

In accordance with PRIGOGINE's extension of **thermodynamics** to **open dynamic systems**, ROWLAND also observes that dynamically maintained patterns: "... require the **dissipation of energy** for their **maintenance**" (p.123).
→ "**Oscillators (Coupled)**"

2503

PATTERNS ASSOCIATION ²⁾

The formation of associations between patterns is a very important ability of neural **circuits** in the **brain**.

It corresponds to a **phenomenon** thus described by P. DENNING: "... the **memory** is sparse because the physical locations are a vanishingly small **subset** of the **memory space**; it is distributed because a pattern is stored in many locations and retrieved by statistical reconstruction from many locations. **Distribution** enables the **memory** to retrieve a stored pattern when the **input** cue only partially matches any stored pattern, an ability that arises from the large overlap between the spheres of selected locations of two similar cues" (1989, p.334).

Patterns association is now researched on **connection machines**, as another example of **feedback** between **parallel computer** research and **brain** neurology.

2504

PAY-OFF ¹⁾²⁾⁴⁾

In mathematical, **game theory**, the **gain** or loss of a player.

It can be formalized through a pay-off **function**.

The concept of pay-off may however lead to an oversimplified view of more complex **issues**, not reducible to game theory.

The ecological "game" (and probably in the long run the economic global **gain**), for ex. is implicitly based on the **stability** and supposed inexhaustibility of the environmental **resources**. This leads to probably illusory **models of positive-sum games**, i.e. obtention of pay-offs ...that must never be payed for, since natural **substrate** is the invisible loser

Any game theory concept applied to complex **issues** should be at least two-tiered, i.e. complemented hierarchically by a super-game of players against the **environment**.

Permanent **carrying capacity** should be monitored, and this could possibly be done through national and planetary **patrimonial accounting** of natural renewable and non-renewable resources.

→ **Commons; Economics in systemic terms**

2505

PERCEPT ^{1) - 3)}

1. "The basic unit of experience" (W.T. POWERS et al., 1960, p.63).

POWERS et al. state that "It is that '**bit**' of **perception** which is self-evident to us, like the intensity of light, or the taste of salt" (Ibid).

"Self-evidence" is always somewhat dubious and it is possibly not *that* simple: How do we connect percept with **gestalt**? Is **gestalt** already an integrated **set** of percepts? What about the synthesis of color, verticality, horizontality and three dimensionality in visual percepts?

A. BRAVOS and P.H. GREENE, who propose a similar definition, list the following basic percepts: "... spatial orientations such as verticality (up-down), relative positioning (front-back and near-far), containment (in-out), horizontality (path), and various internal and external forces such as discomfort, pleasure, effort, compulsion, novelty, boredom, and cold, light and dark" (1992, p.1586).

The establishment of percepts – and still more so of concepts – is thus conditioned by existing basic **contexts**, as for example gravity or electromagnetic waves.

As to concepts, their existence postulates in an implicate way that all living beings (or at least all living beings on this planet) have more or less the same basic physical sensations, as for example phototropism as a response to light.

As to the supposedly more or less similar internal effects of sensations, human beings are trapped within their humaneness. (What does the dog see when we see "red"? And even, is seeing "green" for you the same than for me?)

As advocated by W. FRITZ, it would be interesting to scrutinize the possibility of endowing artificial beings with complex **arrays** of percepts (1984, 1989).

From a different perspective, G. PASK writes: "A real **observer** is able to recognize some, but not all, possible forms of **behavior**. These recognizable forms are his percepts and there is a finite **set** of them" (1961, p.21).

This set can however be extended: "Individuals circumvent their imperfections by forming a simplified **abstraction** of the real world, through **learning** and concept formation (as a result of which, amongst other things, they learn to recognize new percepts)" (p.22).

2506

PERCEPTION ^{1) - 3)}

1) An effective adaptive internal **response** to a **stimulus**.

This is merely one way to view perception. The subject is and probably will remain widely discussed and controverted. The following quotes only introduce some characteristic, more or less systemic views.

R.L. ACKOFF and F.E. EMERY add to the definition that the **stimulus** should "... produce a **change** in at least one **structural** property of the respondent" (1972, p.66).

Perception implies of course an **observer**, whose **phenomenological** and **epistemological** status is quite difficult to determine (see von FOERSTER's comments on the **observer** and "**Observing systems**").

J.J. GIBSON for ex., states: "Perceiving is a psychosomatic act, not of the mind or of the body, but of a living **observer**... It is a keeping in touch with the world, an experiencing of things rather than having an experience. It involves awareness-of instead of just awareness" (1986, p.239 -40).

For K. SAYRE: "Perception occurs within a cascade of **information channels** originating at the surface of the perceptual **object** and terminating in the cortex of the perceiving **organism**...

"This characterization is general enough to hold true independently competing views about the nature of the intermediate stages. It is true for someone (like ARISTOTLE) who holds that **structure** present in external **objects** are conveyed directly to the sensorium of the perceiving **subject**, as well as for someone (like LOCKE) who holds that there are intermediate **objects** (such as sense-data) of which alone the **subject** is directly aware. It is true for someone (like BERKELEY) who treats perceptual awareness as a passive **response** to external influences, as well as for someone (like KANT) who emphasizes the participation of the mind itself in the formation of the **structures** of which we are aware" (1976, p.153).

Of course, such an omnibus explanation does not explain much about "the nature of the intermediate stages".

From another angle, D. Mac KAY writes: "It is not denied that in **observer-language** we can distinguish two stages. Of all the **objects** in the **field** of vision, for example, only a few are normally perceived at any one **time** – those that have "caught the attention" as we say. **Stimuli** corresponding to the presence of the others are received; but they evoke no "matching **response**" in the **organism**" (1956, p.105)... "at least none structured to correspond to the individual **objects**. These **objects** are not *perceived*" (Ibid, p.61).

This corresponds obviously to BRENTANO's perceptive intentionality. Also, as expressed by von FOERSTER: "The keys to perception are not only the sense **organs**, but moreover in their **interaction** with the **motor** system" (1992, p.76).

2) "The adaptive updating of the **state** of orientation" (of the system) (D. Mac KAY, 1969, p.98).

According to Mac KAY: "A solitary **organism** keeps its orienting system up to date in **response** to physical **signs** of the **state** of the **environment**, received by its sense **organs**" (Ibid).

An integrated system also perceives – at least up to some point – what happens inside itself.

2507

PERCEPTION (Constancy of) ^{2) - 3)}

K. LORENZ emphasizes the importance of acquired constancy of perception as a condition for **survival** of **living systems**. He distinguishes particularly constancy of **form**, of direction and of color (but various other types of perception could be mentioned) and more or less equates the **process** of constancy acquisition to the formation of **Gestalt** (1962, p.44-47).

Living systems do progressively construct and stabilize perceptive **algorithms**, probably through **organization** of **neural networks**.

Constancy of perception is obviously an extremely important aspect of **organizational closure**, **autopoiesis** and **autonomy**.

2508

PERCEPTION (Dispersed) ¹⁾³⁾⁵⁾

The **simultaneous perception** by different senses organs of distinct characteristics of the same **object**

Sometimes even, the same organ seems to perceive separately various features of the object and connect them in a significant **synthesis**...or differentiate them by shifting from one **receptor** to another.

ASHBY notes for example that "In the skin are histologically-distinguishable receptors sensitive to touch, pain, heat and cold. If a needle on the skin is changed from lightly touching it to piercing it, the excitation is shifted from the "touch" to the "pain" type of receptor; i.e. **dispersion** occurs"(1960, p. 180)

Perception of **space** offers another example. It is in fact a complex **synthesis** of specific perceptions of verticality, horizontality and deepness.

2509

PERCEPTION (Ecological) ^{2) - 3)}

J.J. GIBSON developed an ecological theory of perception akin to J.von ÜEXKULL's "Bedeutungslehre" (Science of **significances**) (1934, 1979). He writes, for instance: "Knee-high for a child is not the same as knee-high for an adult, so the **affordance** is relative to the **size** of the individual" (1986, p.128).

GIBSON's theory is basically about **visual** perception ("Ecological optics"), indeed generally the most used and important tool for our **observation** of the world.

It is based on ecological **observation** by living beings, principally what these living **observers** "make" of what they see, how they see what they see and to which uses they put their perceptions (see "**affordance**": What are the uses of what they see for any of them, on the base of their *tacit knowledge*).

GIBSON's theory implies:

- 1) That perception is based on the general conditions proper to this planet: gravitation **level**, imperceptible curvature, atmospheric density and transparency (compared for ex. with the characteristics of the aquatic **medium**).
- 2) That each **observer** needs to train her/himself in ecologically satisfactory interpretations of her/his perceptions. This is tantamount to PIAGET's **ontology** of **knowledge**, to von FOERSTER's **2nd cybernetics** and to **autopoiesis**. Perception is not a **response** to a **stimulus** (a mere "brief and discrete application of **energy** to a sensitive surface") (p.57), but an act of **information** pick-up. It thus implies the **construction** of inner **rules** of interpretation, based for each species (and individual) in its sensorial equipment.

GIBSON's concept seems important for our ways to define and use perceived entities, and our relations to them.

2510

PERCEPTION (Limits to) ^{1) - 3)}

There are many significant limits to perception. D.H. MEADOWS et al. put this in the most general terms as follows: Although the perspectives of the world's people vary in **space** and **time**, every human concern falls somewhere on a space time **graph**" (D.H. MEADOWS et al., 1977, p. 19)

(See the graph "Cognitive spaces", an adapted form of the timegraph)

Physiological limits

J.P. CHANGEUX writes: "An alteration in **environmental** properties becomes an **event** for the concerned **organism** only to the point that its physical characteristics enter within the sensibility **domain** of its **receptors**. What may be an **event** for an insect, possibly will not be one for a vertebrate, and conversely. However, the diversification of **receptors** types in the superior animals allows them to perceive the **event** in a more complete manner, even if still limited and partial" (1972, p.391).

A good example is the case of the frog put in cold water, very slowly heated. As the frog does not perceive the quite progressive temperature increase, it is in great danger to be boiled before becoming aware of it.

Once the **event** becomes registered as a **signal** at the **level** of the sensorial **receptor**, it is converted into an electrical impulse or **action** potential.

"Only the **frequency** or the number of these **action** potentials may vary in relation to the **stimulus** nature or intensity and then, only within narrow **limits**...

"The sensorial **organs** thus transform the specific and various **signals** from the external world in conventional ones. When crossing the **boundaries** of the **organism**, the **signal** loses, apparently, its specificity, its **information content**. Actually, the specificity of the received and transmitted **signal** is not lost: it is taken up through the specificity of **connections**, the lines linking the sensorial collectors with specific neural relays in the nervous center" (p.39).

However, during this internalization **process**, much of the original potential **information** is lost. According to H.von FOERSTER: "Since there are only a hundred million sensory **receptors** and about ten-thousand billion synapses in our nervous system, we are 100.000 times more receptive to **changes** in our internal than in our external **environment**" (1981, p.300).

It could be added that only during this century man learned to register and *translate* through technical means some alterations of the **environment** (X rays, electromagnetic **waves**, for example) in order to enable his sensorial **receptors** to perceive them, at least indirectly: we still do not know what we would "see" or "hear" if we were sensorially better endowed.

We use these interpretations, acquired by **learning**, to observe the world around us. Such **observations** are by no means pristinely pure. Our physiological observing **subsystems** act as **filters**. We do not see, hear, smell, or feel everything that could be observed, not being able to perceive, for example, infrared, ultraviolet light, or ultrasonic waves. On the contrary, we may perfectly "see" lights or shades that are optical illusions. Thus, the **information** we obtain possess no absolute **ontological value**.

Psychological and mental limits

We perceive in accordance with our **frames of reference**, which are constructed in a progressive way by **learning** and training in specific **environments**.

In this way a painter becomes much more able to distinct shades of colors, and a musician the specific tonality of different instruments and the sounds harmonics.

In a similar fashion, a trained physician will produce better and swifter diagnostics than a student.

On the contrary, the untrained person is barred to see, hear or understand many **signs** in any specific trade.

One lesson is that the non-systemist will generally be unable to see not very obvious **interrelations** among **elements** in a system or **events** in a **situation**.

Perceptions are also oriented – or stunted – by our specific needs or interests. This is "perceptive intentionality" (See above and hereafter).

Cultural limitations

The way perceptions are trained and educated strongly depends upon the cultural settings.

Esquimos learn to recognize many important and distinct aspects of snow, while old seafarers knew much about winds and waves.

The ways to represent perspective have been very different in Western and in Far-Eastern painting.

Cultural limitations do also change through time. Modern Western perspective was unknown in Medieval painting.

Limits to perception lead frequently to serious misunderstandings between people and to deficient awareness in complex **situations**.

2511

PERCEPTION (Purpose in)³⁾

... or, in M. MERLEAU-PONTY's terms "perceptive intentionality" (1945).

In G. BATESON's words: "I, the conscious I, see an unconsciously *edited* version of a small percentage of what affects my retina. I am guided in my perception by **purpose**.

"I see who is attending, who is not, or at least I get a myth about this **subject**... It is relevant to my **purpose** that you hear me..." (1973, p.408).

Perception must by necessity be selective. Otherwise we would be submerged by it and unable to act anymore. Such a purposeful **organization** of perception is the result of the progressive **organization** of our **neural networks**, through imprinting, **training**, or **learning**.

There is however a price to pay: **selectivity** blocks us slowly in **routine** grooves and much of reality becomes **invisible**, or again, subtly *edited*. As expressed in a untranslatable German pun by H.von FOERSTER: "...was man wahr-nimmt, nimmt man für wahr" (1992, p.51).

2512

PERCEPTION (Selective)³⁾

According to H. SIMON, any person perceives these aspects of a **situation** specifically related to his/her own **activity** and **goals** (1958).

Such selectivity is necessary in order to avoid drowning oneself in the excessive **flow** of available **information** and succumb to **overload** (as could become a result of Internet overflow, for instance).

However, it may lead to a *selective blindness* or *deafness* which produce partial or total loss of **understanding** of the general **reference frame**. Moreover, in K. BOULDING's words:

"The spread of specialized deafness means that someone who ought to know something that someone else knows isn't able to find it out for lack of generalized ears" (1956).

2513

PERCEPTION (Temporal limits to)^{2) - 3)}

Living beings in general, and man in particular, are sensorily, nervously and socially ill-equipped to perceive **changes** that are slow in comparison with their **life-time**.

This leads, in the case of **human systems**, to very serious **monitoring**, **forecasting** and **planning** problems, because frequently the very most basic **trends** escape attention... until it is too late to do something very useful about it. Practical example are plentiful: Disasters in flood plains unduly occupied; **planning** disasters like the drying up of the Aral sea; overfishing in the oceans; poisoning of the phreatic tables by agro-chemicals; etc...

Mankind should urgently need qualified **long term** systemic watchmen and women.

→ Wave and tide model

2514

PERCEPTION through the mind³⁾

D. BOHM and F.D. PEAT state: "... in science, perception of similarities and differences takes place primarily through the mind (e.g. NEWTON's perception of a certain basic similarity between the apple, the moon and the earth), and much less through the senses. As science developed, this aspect of perception through the mind grew more and more important. Indeed, very little of what could be called direct senses perception takes place in physics today" (1987, p.45).

As perception grows steadily more indirect, the human **brain** seems to respond with a growing **endogenous** creative **activity**. This was surely perceived by EINSTEIN, when he proposed to use "thought experiences".

In **systemics** too, the mind seems to guide perceptions more and more, as for example through J.de ROSNAY "macroscope", or MANDELROT's **fractals**.

2515

PERCEPTRON⁵⁾

An electro-mechanical device able to recognize some **patterns** among a number of **stimuli** it is able to register.

The perceptron was developed by F. ROSENBLATT during the fifties. It consisted of a trainable **network** of connected **nodes** that interacted in such a way as to be able to "learn", at least to a limited degree.

Each **node** could do simple calculations like adding and subtracting, based on received **signals**. It was also able to emit some **signals**. To decide which **signal** to send, a **node** adds up its **inputs**, after "weighing" them through

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

very simple **mechanisms**, and thus giving them different values. Positive weights make the **node** more likely to emit if it happens to receive this same specific **signal**, and conversely, with negative weight. A perceptron is more or less progressively self-programmed, as it becomes able to define "right" answers and, by further use of the weights, to close in evermore on them, through a discriminate use of its **inputs**.

ROSENBLATT considered at the time that the perceptron was a probabilistic **model** "for **information storage** and **organization** of the **brain**", and "as a **concept** it would seem that the perceptron has established, beyond doubt, the feasibility and principle of non-human systems which may embody human cognitive **functions** at a **level** far beyond that which can be achieved through present day **automatons**" (F. ROSENBLATT, 1958, p.449)

The perceptron was shelved for many years after M. MINSKY and S. PAPERT showed in 1969 the practical difficulties for any efficient self-programmation. in order to obtain really interesting results. They proposed instead the "top-down" approach to **artificial intelligence** by the introduction of **programs** for the manipulation of abstract **symbols** representing **knowledge**, and **transformation rules**.

The same problem had also be signaled by F. OFFNER in a 1965 paper (p.195-200).

Such a critique is seemingly at the same time well founded and off the mark. The perceptron is by necessity a highly **parallel machine**, thus inevitably **chaotic** and practically unprogrammable. But, as observed by E. ANDREWSKY, such systems "do not have central units, and each of their **elements** functions in its local **environment** in order to determine a global **cooperation**, that is the system's **self-organization**. The **network** shapes itself progressively through the **stimuli** it receives; in other words, its **learning activity**, which is continuous during its implementation, results in **changes** of the **network** itself (whereas classically, **learning** is only **change** in **knowledge representation**)" (1993, p.193).

"Global **cooperation** in local **environments**" leads to the very interesting new field of **computational ecology** (B.A. HUBERMAN, 1988).

ROSENBLATT's idea has resurfaced in the eighties in the guise of the **connexion machines... or interactions among machines**. As stated by P. DENNING this was made possible when "several investigators independently discovered how to transform ROSENBLATT's perceptron **learning heuristic** into a precise **algorithm... called backward error** propagation, because errors in the **output** are used to adjust the weight applied to the **inputs**. One version of the backward **error** propagation **algorithm** was described in 1986 by D.E. RUMELHART and J.L. McCLELLAND and their colleagues" (1992, p.427).

2516

PERCEPTUAL CONTROL THEORY ¹⁾²⁾⁵⁾

Perceptual Control Theory (PCT) (in living beings) has been introduced by W.T. POWERS, who states that it "was originally inspired by the work of the early cybernetists (WIENER and ASHBY primarily)" (from POWERS internet page).

However, PCT presents a much more elaborated view of controlling as related to a wide variety of **perceptions** in living beings. This is still more so in human beings who are **willful controllers**. Their **relationships** with their **environment** is not merely biological, nor limited to "here and now". On the contrary, they are so complex as to need a very high degree of **interrelation** and interpretation. This is provided by physiological **sensors** of different kinds (now moreover aided by an **array** of enhancing artificial devices), and by the hypercomplex **organization** of **neural networks**.

POWERS introduces new notions to cover these aspects, under others **environment functions**, **reference** conditions and discriminative **stimuli**. He also expands the meaning of **amplification**, **control** and **purpose**.

2517

PERCEPTUAL FIELD ²⁾:

The **set** of organized perceptual abilities in a **subject** (After K. SAYRE).

This author contemplates the existence of several different associated perceptual **fields**: visual, auditory, tactile...

He adds: "If the objective presentations constituting a given **field** from moment to moment are focused around a constant "inward locus", this subjective locus assumes the character of self-**identity** through **time**... The **subject** thereby both provides temporal **continuity** to the individual **field** of awareness and serves as a reference by which different **fields** can present simultaneous appearances. As KANT remarked with typical acuity, while **space** is the form of all outer appearances, all inner determinations are represented in relations of **time**" (1976, p.246-7).

2518

PERCEPTUAL FILTERS ^{1) - 3)}

Any sensorial **organ** or part of the nervous **subsystem** which reduces our capacity to observe our **environment**.

Our five generally recognized sensory **organs** all act as perceptual filters. For ex., our sight cannot recognize infra-red or ultra-violet radiations, or may in some cases confuse colors (Daltonism). This renders our sight incomplete, and even in some cases unreliable.

The way sensations are translated into nervous **inputs**, and notably the ways these **inputs** are converted and become interconnected in the **brain**, may also produce a filtering or warping effect.

In this way, **ambiguities** and erroneous interpretations can appear as for example optical or auditive illusions.

Finally, some cultural traits may generate perceptual filtering effects through a different quality or **level** of sensorial education. As an example, the perception by Indian Raga musicians of 1/9th of tones is more acute than the Occidental perception of mere 1/2 tones.

The existence of perceptual filters is very important for any good theory of the **observer**.

→ **Blindspot**

2519

PERCEPTUAL PROCESS ^{1) - 3)}

"A specific **function** (**activity**, **process**) of a sensory system and of the plastic neural systems directly coupled to it" (M. BUNGE, 1979, p.152).

BUNGE gives the term "**percept**" as a synonym for "perceptual system". In order to avoid confusions with the commonly accepted meaning given to "**percept**", it seems better to retain the latter expression.

2520

PERCEPTUAL-MOTOR ARCH ¹⁾²⁾³⁾

"The perceptual-motor arch considers the **process** of **decision making** in respect to the duration from **perception** of the **current situation** to the formation and execution of the **response action**" (M. KALAJDIEVA, 1999)

This Bulgarian author comments: "The perceptual-motor arch is systematized in seven **levels** of **complexity** of intelligence. Four further levels of memorizing and retrieving efficient **algorithms** for decision-making and reaction-forming are mentioned. It is assumed that human **memory**, intelligent technologies and **knowledge** processing are far superior to nowadays computers; that programs of **reaction**, encapsulating the decision made, and evaluation technologies which are memorized, can be trained by repetition and inherited as "hardware". The investigation aims at ways to animate humans to become more sensitive to conscious **behavior** in **crises**, to evaluate and then (re-) act and enhance intelligent **agents** systems" (Ibid)

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2521

PERCOLATING CLUSTER ²⁾

An expanding cluster of **elements** that crossed the critical **threshold** from which the **process** is able to propagate itself without restrictions in a sufficiently **homogeneous medium**.

In such a case, the percolating cluster expands itself rapidly, occupying the major part of the available **space**.

This is however generally a self-destructive **process**, or at least a self-limitating one. If the cluster is made of sick individuals, they die or cure themselves. If it is made of trees, their becoming burned trees slows down or finally stops the fire.

2522

PERCOLATION ²⁾

Propagation mode of a **process** in a **medium** or a relatively **homogeneous** system, characterized by a sudden **discontinuity** at some precise instant, depending on a **critical density** of the main **component** in that **medium** or system.

In **random graphs** used as **models** "...percolation **thresholds** occur ... and determine when large, connected **webs** of **elements** will form. Below the **threshold**, such **webs** do not form; above the **threshold**, they do" (S. KAUFFMAN, 1993, p.205).

This is a **dynamics** of contagion and apply only to almost **homogeneous** systems. The concept was introduced by the English mathematician J.M. HAMMERSLEY in 1956, and corresponds to a general **model** which permits a better **understanding** of numerous **phenomena**, as for example:

- epidemics and epizootics
- forest and bush fires
- pest invasions in fields and orchards
- mud or rock slides, or snow avalanches
- the triggering phase of numerous chemical **processes**

On this side of a defined **density** of the principal **component** of the system or **medium**, the **process** remains confined and cannot propagate itself to the whole system.

P. GRASSBERGER, using the example of a specific pest invasion in an orchard planted with various kinds of trees, observes that: "One may ask oneself if the chances of a pest to invade one by one all of the apple trees do increase regularly with the proportion of apple trees..."

"Such is not the case. Quite surprisingly, the pests chances to run from one to the other extremity of the orchard are practically nil under a certain proportion of apple trees but become practically 100% over that value..."

"Percolation functions are like an **"all or no-thing process"** (1991, p.640).

Of course, it is implied that no perturbing factor does interfere. The **situation** would be quite different if a strong wind should transport the insects far away (see **"Oriented percolation"**) or if the affected **population** members would be able to travel at great distances.

2523

PERCOLATION (Oriented) ²⁾

A percolation **process** submitted to some **constraint**, in **space** or in **time**.

In an abstract **model**, it is for instance possible to impede **propagation** in one or various defined directions.

Using the example of a forest fire, the direction of the wind may favour percolation in one direction and impede it in another one. It is altogether obvious that, when the percolation **process** implies the destruction of the affected **elements**, it will not be able to propagate itself again in zones where **populations** have already been devastated. Where the fire has raged, there are no more trees to burn and where the epidemics raged, the number of immunized or naturally resistant individuals is much higher than the one of the individuals who could yet succumb to the illness.

This **phenomenon** also shows up in the **time** dimension. A destroyed forest will need a long **time** to become again a combustible forest. In the case of epidemics, increasing **survival** of immune and immunized individuals at each resurgence of the epidemics lead normally to such a **situation** where the percolation **threshold** cannot be reached anymore, at least for long **time**.

2524

PERCOLATION THRESHOLD ²⁾

The **limit** under which a **process** cannot propagate itself in a **medium** or an almost **homogeneous** system or, on the contrary, beyond which it propagates without **limits**.

This threshold, which is expressed by a %, depends on the spatial arrangement of the **elements**. P. GRASSBERGER, using the very simple example of a bicolor **net** of square **components**, shows that the percolation threshold is theoretically at 59,29% When this **limit** is reached, percolation triggers and isolated **clusters** of the most numerous **components** percolate, i.e. become interconnected and invade the near totality of the surface, confining in turn the less numerous **components** into small **clusters** isolated from each other (1991, p.649).

In this way, for example, epidemics become pandemics.

The existence of percolation thresholds explains the better **stability** of very **heterogeneous** systems as, for example, the natural ecological systems differentiated in very numerous niches corresponding to many species.

GRASSBERGER, moreover, points out that "...in the **vicinity** of a percolation threshold, the behavioral differences between various systems become blurred and all show a *truly universal behavior* Their properties do not anymore depend on their particular **structure** but on the contrary, obey to global laws called **"scale laws"**. However, while this universality is now well confirmed, a complete mathematical formulation is still lacking. It is not always evident... how to distinguish from the start which are the universal **magnitudes** and which are the details of the **structure** which should be neglected" (p.642).

2525

PERFORMANCE ¹⁾

The results effectively obtained through a **process** or by a system, compared with the **maximum** possible or suitable **optimum**.

The definition emphasizes two different possible **criteria** for measuring performance. Of course, the **maximum** possible does not always corresponds to the suitable **optimum** because, in a **complex system**, each **subsystem** or **process** does not only work for its own benefit and, in many cases must, or should respect **constraints** needed to secure the best possible general performance of the system as a **whole**.

2526

PERIOD ²⁾

The **time span** needed for covering the successive **phases** of a repetitive **cyclical process**.

In complex **processes**, a mix of various periods at even very different **time scales** may happen and the general **cyclical** character of the **process** may remain hidden. A period, very long at human **time scale**, may also be confused with a **trend** or even not be perceived at all.

Already L.von BERTALANFFY believed that a general theory of **periodic processes** would be a necessity for various scientific disciplines (1968).

K.DE GREENE has recently returned to this study in a series of thought provoking papers (1988 to 1991).

2527

PERIOD-DOUBLING BIFURCATION ²⁾

A **threshold** in a **process** that tends to turn **chaotic**, signaled by the replacement of a period **n cycle** by a period **2n cycle**.

After such a bifurcation the repetition of a certain **state** of the system needs twice the number of time-steps. When repeated time and again these **events** are akin to a **fractalization** of the **cycles**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

In the case of the **logistic equation**, as stated by R. JENSEN: "The range of (the **parameter**) *a* over which a single **cycle** is **stable** decreases rapidly as the period of the **cycle** increases, which accounts for the rapid **accumulation** of **cycles** with larger and larger periods" (1987, p.171).

For $a \geq 3.57$ the global **cycle's** period becomes infinite.

2528

PERIOD-DOUBLING SEQUENCE²⁾

A succession of period-doubling **bifurcations**.

Period-doubling was discovered by M. FEIGENBAUM.

An orbit on the **trajectory** is replaced by another one twice as long at each time-step *t*, while the **time** needed for a repetition of any **cycle** is twice the number of time-steps. The longer the period, the faster the period doubling and the smaller the distance between neighbouring points on the orbit: This is a **fractalization process**.

In this way the **process** acquires a growingly **random** aspect that makes it more and more difficult to observe. A **sequence** of regular **oscillations** suddenly gives way to unpredictable **behavior**, and back again to a new **pattern** of **oscillations**, and so on, but within shorter and shorter **time spans**. The **process** remains however basically **deterministic**, at least globally.

A period-doubling sequence is the signature of **chaos**.

→ "Logistic equation"; "Renormalization".
For more precise information, see JENSEN (1987).

2529

PERIODIC AND QUASIPERIODIC MOTION²⁾

"The combination of two independent periodic motions produces a **toric attractor**. A quasi-periodic orbit winds itself round the torus like cotton on a bobbin" (I. STEWART, 1989, p.45).

More than two independent periodic motions generally produce, when combined, a **chaotic behavior**. In J.P. ECKMANN's words, in such case the system may explore "in several occasions the same **instability** without **periodicity**" (1992, p.113)... Or possibly, periodicity is so complex and at such a long **time scale** that it becomes practically unobservable.

P. BERGE and M. DUBOIS describe the "three principal ways that may lead to **chaos** starting from a periodic **regime**:"

"1. by **period doubling**, for which period is doubled at each **bifurcation** until nearing a period of infinite length;

"2. By **intermittences**, for which periodic **states** slowly destabilize until there is a "puff" of **turbulence**;

"3. by quasi-periodicity, for which the **non-linear interaction** of 2 (or 3) **oscillators** leads to **chaotic behavior**" (1992, p.128).

→ Quasi-periodic

2530

PERIODICITY^{1) - 2)}

The more or less regularly recurrent and more or less similar **variations** of a **function** or a systems **behavior**.

Periodicity implies a succession of **cycles** of regular or irregular **frequencies** and **amplitudes**. The following types of periodicities could be distinguished:

- **mono-cyclical**: corresponding to only one **cycle** of defined **frequency** and **amplitude**. Such periodicity is perfectly **predictable**. In many cases, when others **cycles** with very short or very long **frequencies** and **amplitude** are present, they escape **observation** for long **time**, or they seem to be **trends** and the mono-cyclical **model** remains generally adequate.
- **commensurable, bi- or poly-cyclical**: this case corresponds to the interferences and combinations of **cycles** of various commensurable **frequencies** in harmonic relation in **phase** or out of **phase** (f.ex. 2, 3, and 6 or, more complicated, 9, 12, 27). Such periodicities are still regular and **predictable**, but more intricate, difficult to observe and complicated to analyse. In some cases, **fractal** periodicities can be found. See: "Self-similarity in WEIERSTRASS functions".
- **uncommensurable**: This case corresponds to the interferences of various **cycles** with **frequencies** corresponding to **prime numbers**. In simple cases (f. ex. 2, 3, 5, and 7), **observation** and **predictability** seems still more or less manageable, using lowest common multiples (here, 210). However, for compositions of more, or greater **prime numbers**, regularities may become practically unobservable and the system may appear **chaotic**, i.e. globally **deterministic** only in the very **long term** and this merely in case of absence of any **environmental perturbation**.

2531

PERIODICITY (Linear)²⁾

Periodicity of a **function** which can be reduced to a combination of a **set** of simple linear **functions**, even if complex.

Writes F. ROBB: "The elucidation of such **functions** has been the overriding concern of scientific analysis. The results have often passed off as causal "explanation". From this point of view, a **complex linear system** is seen as being no more than the sum of its **parts**, and the **behavior** of the **whole** can be reduced to that of a simple **operator**" (1989, p.55).

However, **complex systems** are generally **nonlinear**. This is the rule when three or more **initial conditions** act simultaneously in different **parts** of the system. In this situation, the global **determinism** becomes highly complex and leads to a growing **randomness** which makes the **behavior** of the system more or less unpredictable.

2532

PERIODICITY PRINCIPLE¹⁾

According to W. SCHWEMMLER (1991), periodicity seems to be a very basic feature of cosmic **evolution**. Such regularity would apply to the progressive **emergence** of evermore complex systems during cosmic **evolution**, through **association** and **integration** of simpler **elements**. SCHWEMMLER distinguishes four **levels** of **emergence** of this type:

- Elemental **symmetries** among particles at subatomic **level**
- Periodicity at the **level** of chemical **elements** (MENDELEEV)
- Periodicity in elemental **levels** of biological complexity (MARGULIS et al.)
- Possible periodicity in the emergent cultural genesis.

This is of course quite hypothetical, but the **similarities** of the different ways of **emergence** of **complexity** in accordance with their succession in **time** lend credibility to the idea. More research would be very useful.

C. BRESCH proposed and developed similar ideas (1977)

2533

PERSON

→ Individual

2534

PERSPECTIVISM^{2) - 3)}

I.V. BLAUBERG, V.N. SADOVSKY and E.G. YUDIN explain: "Perspectivism is founded on the idea that general **categories** of thought are similar in widely differing branches of modern science, hence the possibility of evolving a unified science on the basis of **isomorphy** of laws in its various fields. That makes it possible to speak of the **structural similarity** of the theoretical **models** used in various fields of science" (1977, p.53).

Prof. ELOHIM j.l. organized in Vienna (2002) a symposium about "Development as a Systems **Epistemology**", dedicated to BERTALANFFY's view on the subject.

He wrote: "The BERTALANFFY's perspectivism in practice oblige every learned person, while learning, to be aware of his/her relative ignorance, to recognize that using his/her **brain** to the utmost he/she must increasingly try to be aware of the **limits** of his/her powers of **cognition**, because "perception is not a reflexion of "real thing", but rather is an **interaction** be-

tween knower and known". It means that the result of every **observation** is partly the result of the viewpoint and **methodology** of the observer".

And "...all what seems to be objective perception of real **facts** and **events** is filtered by the biological features of the **observer** and his/her psychocultural achievements"(pers. comm.)

These early insights of Bertalanffy have been widely confirmed in different ways by scientists and scholars like L. WITTGENSTEIN, K. POPPER, H.von FOERSTER, H. MATURANA, F. VARELA, E.von GLASERSFELD and some others.

Perspectivism has also a more directly human and psychological value, when understood as an interactional behavior between people. This view has been developed by the Dutch andragology school, among others by W.J. WITTEVEN who writes: "The perspectivist procedure leads to comparison or arguments" and "Perspectivism requires the readiness to weight different principles in new circumstances. It requires openness to new participants in the ongoing **conversations**"(2000, p. 86)

→ **Asilomar Conversations; Cybernetics (2nd order); Facilitation; Facts as constructs; Fuschl Group; Multi-perspectivism; Ontological skepticism; Systeem Groep Nederland**

2535

PERTURBATION ^{1) - 2)}

Any input that modifies the **dynamic equilibrium** of a system or a **subsystem**, be it in a reversible or irreversible way.

The concept of perturbation is somehow ambiguous.

J.A. GOGUEN and F.J. VARELA state: "If we stress the **autonomy** of a system... then the **environmental** influences become perturbations (rather than **inputs**) which are compensated for through the underlying **recursive** interdependence of the system's **components**" (1979, p.34).

The same situation exists between **subsystems** within the system. Each of them may receive from others **inputs** that perturb it.

There is however a considerable difference between so-called perturbing **inputs**: To ingest strychnine is not, as an **input**, in the same class than eating bread, as the first one will, irreversibly, kill the system while the second one will benefit it, allowing it to return to its own type of **dynamic stability**.

Perturbations play a very important role near an **instability threshold** in systems affected by giant **fluctuations**. Such a perturbation – in most cases a **random environmental event**, or **noise** – may destroy the former organized **structure** and induce a **bifurcation**, toward a different **structuration** through **dissipation**.

However, a perturbation can have this effect only if it does not throw the system out of its **historical macro-determinism**, destroying it in the **process**.

"Perturbation" seems to be frequently used as a near synonym of "**disturbance**".

2536

PERTURBATION (Endogenous) ^{1) - 2)}

Anomalous **variation** of one or various **functions** of the system, which endangers its correct working and in some cases it very **survival**.

Any **homeostatic system** possess the capability to fluctuate inbetween maxima and minima **limits** of **stability**, generally in order to adapt itself to **variations** of its **environment**. The **fluctuations** relate in most cases to one of the **functions** or **subsystems**.

However some **fluctuations** may cross some **stability threshold** of the system, not allowing any more a return to the **steady state**. If no other **subsystem** is able to compensate adequately this **disequilibrium**, the system is heading for destruction or, in some very exceptional cases, undergoes a very radical **transformation (emergence process)**.

Endogenous perturbations are generally the final results of an **accumulation** of **exogenous variations** or perturbations. In some cases however, these are in turn a result of the systems actions. An example are cardio-vascular diseases, due at least partly to excessive smoking or inconvenient diet.

2537

PERTURBATION (Exogenous) ^{1) - 2)}

Anomalous **variation** of the **environment** which impairs the correct working of the system or of one of its **parts**.

Any **viable system** is adapted to a specific **environment**, according to its perceptive abilities, to the internal **organization** that it obtained from former systems, to the **learning processes** it underwent, and its ability to use its internal **variety** or **reserves** through its **regulation** devices.

The **environment** may fluctuate within some **limits** without endangering the system, but these **limits** correspond, of course to the **limits** of the systems possibilities of **adaptation**.

A similar idea was enounced under the guise of the "**Law of Requisite Variety**" by ASHBY.

I. PRIGOGINE states that "dynamical systems have no way to forget perturbations" (1985, p.7). A recent example of this has been the destruction of Comet SHUMAKER-LEVY 9 after having its orbit perturbed by Jupiter.

A. LIONI gives an interesting example of the way an exogenous **perturbation** may convert itself in an **endogenous** one: In a public bus line, when a unit is delayed by an environmental incident, the **delay** tends to extend itself be-

cause in the mean time more passengers have accumulated on the next stops. As a result the next units in the line crowd up with fewer and fewer passengers and the exogenous perturbation finally generates a global **endogenous perturbation** (2000, p. 149)

→ **Collective behavior; Delay amplification; Queuing theory**

2538

PERTURBATIONS in networks ²⁾:

St. KAUFFMAN distinguishes as follows minimal and structural perturbations in networks:

"A minimal perturbation is a transient flipping of a **binary element** to its opposite **state of activity**. If such a **change** does not move a network outside its original **basin of attraction**, the network will eventually return to its original **state cycle**".

"A structural perturbation is a permanent mutation in the **connections** or in the **Boolean functions** of a network. Such perturbations would include exchanging the **inputs** of two **elements** or switching an **element's OR function** to an **AND function**" (1991, p.66).

2539

PETRI NETWORKS ¹⁾²⁾

"An oriented graph used to describe the **behavior** of **asynchronous sequential automata**" (A. LEROY AND J.P. SIGNORET, 1992, p.49)

PETRI networks were introduced by Dr. PETRI in Germany in 1962. They are still in a stage of further development.

A PETRI network is made of "places" or "**positions**" which represent the static part of the network.

Tokens are moved from places to places in accordance with some **transition rules** which must be specified. Thus the network evolves from state to **state** by successive steps. During its evolution the PETRI network covers progressively all the possible states of the system under study.

It combines a structural **representation** of the modeled automata and its possibilities of **transformations**, based on the transitions rules. These can be **deterministic** with specified **delays**, or **random** ones, representing in such cases **phenomena** whose occurrence cannot be precisely forecasted.

The authors explain as follows the possible uses of PETRI nets, which sequentially follow the different successive **states** of the modeled system:

- analyse in a detailed way its sequential behavior
- identify the different states in view of creating a **markovian graph** of states
- identify the non-accessible states
- find the **lock-ins**, **delays**, **feedbacks**, etc
- discover **bifurcations** or different possible transitions (Ibid, p. 54)

PETRI networks can be used to modelize projected physical or mechanical systems and discover potential failures, **risks** or incompatibilities. (Adapted from A. LEROY and J.P. SIGNO-RET, 1992)

2540

PHASE COEXISTENCE²⁾

A characteristic of a system endowed with a **variety** of potential phases to which it can switch when necessary in order to maintain its **stability**.

As stated by R. FIVAZ, their existence "... tend to release the system from external determinants", as they "... confer to the system features independent of the **environment** such as **identity** and **autonomy**" (1991, p.25).

This **model** is closely related to ASHBY's **variety**.

FIVAZ shows that phase coexistence **regimes** are alternating with **metastability** phases. He writes: "Each of the two **regimes** influences **parameters** which determine the onset of the other regime: **metastability** increases the system **size** and eventually leads to phase coexistence, whereas phase coexistence modifies internal **couplings** so that a new **metastability** run may start. Thereby, the two **regimes** generate each other and a stage **development** takes place where **maximization** and **hierarchization** alternate" (Ibid).

This could be an interesting explanation for macro-**evolution** toward **complexity** through **structural dissipation** traded against **entropy production** increase.

2541

PHASE LOCKING²⁾

The stable dynamic **relationship** that tends to become established between **oscillators** of various **periods**. (also known as phase blockage).

The simplest cases are those wherein **periods** are equal, or have a simple arithmetical **relationship**.

It is however possible to think of phase locking in complex **interrelations** between **oscillators** of seemingly uncoordinated **periods**. An example is the progressive and spontaneous **synchronization** of pendular clocks, discovered by HUYGHENS (17th Century). The American biologist L. MARGULIS discovered various examples of biological **synchronization** in groups of bacteria and even in the menstrual **cycles** of women living in more or less secluded **groups**.

This could be the nexus with a general theory of complex **cycles**, still to be built, that should explain how **cycles** of widely different **periods** become coordinated or **embedded**.

→ "Order parameter", "Slaving principle".

2542

PHASE PORTRAIT²⁾

"The **set** of all possible **paths** along which the system can evolve" (I. STEWART, 1989, p.44).

This is the potential content of the **phase space** of the system. It is generally not possible to consider all the possible **paths**, but the selection we make must include a critique of our own **choice** and we must never forget that we remain in danger to ignore some alternative solutions, which may reveal themselves more adequate to future reality.

POINCARÉ, who ideated phase portraits, also described the **topological** properties of various singular points in them: **node**, apex, neck, focus.

2543

PHASE TRANSITION^{1) - 2)}

The crossing-over from one **state** to another in a system.

Phase transitions are a common feature in "physical, chemical, biological, mechanical or electrical systems" (H. HAKEN, 1983, p.46). The shift linked to temperature and pressure between different **states** of water is a classical example. Others are the onset of superconductivity or ferromagnetism.

H. HAKEN writes: "Synergic systems may undergo continuous or **discontinuous** transitions, and they may exhibit features such as **symmetry-breaking**, critical slowing down, and **critical fluctuations**" (p.314).

Phase transitions may appear in a stochastic way in **ergodic systems**.

2544

PHASE TRANSITIONS (Nonequilibrium)^{2) - 4) - 5)}

Instabilities that appear in a system driven far from **thermodynamic equilibrium**.

H. HAKEN states: "The nonequilibrium phase transitions of **synergetic systems** are much more varied than the phase transitions of systems in thermal **equilibrium**, and include **oscillations**, **spatial structures** and **chaos**" (1983, p.315). HAKEN also observes: "Destabilization of the former **state** in phase transitions is associated with intense **fluctuations phenomena**" (1984 - as retranslated for the Spanish translation from German!).

R. LEFEVER and I. PRIGOGINE illustrate this **process** using the **BÉNARD instability** "... a striking example of **instability** giving rise to spontaneous **self-organization**" (1986, p.2) and "chemical **oscillations** ... to occur (through) auto- or **cross-catalytic reactions**" (Ibid, p.3). (As for example the BELOUSOV-ZHABOTINSKY reaction).

Still more interesting: "Non-equilibrium transitions have also been described in the slime mold *Dictyostelium discoideum*" (p.4). This suggests that these transitions are important in all kinds of biological and **social systems**.

HAKEN went as far as to write: "The phase transitions theory allows for the identification, in the mechanisms of revolutions, of many of the **effects** observed in the natural sciences" (1984 - retranslated).

2545

PHASES in networks²⁾

St. KAUFFMAN distinguishes "solid" and "gaseous" phases in networks, which means respectively phases in which the **frozen cores** are notably more numerous than the **variable elements** and conversely. Moreover, this author states that: "...as frozen **components** melt, more complicated dynamics involving the complex **coordination** of **activities** throughout a network become feasible. The **complexity** that a network can coordinate peaks at the "liquid" **transition** between "solid" and "gaseous" **states**" (1991, p.68).

2546

PHASES SPACE^{1) - 2)}

The reference space in which all of the possible future **states** of an **object** submitted to various **parameters** are included.

It is also defined as "the **set** of all positions and velocities compatible with the system's **invariances**" (M. FARGE, 1992, p.226).

Or, in J. HOLLAND terms: "... for the **process** X, the set of all possible combinations of values for (the intervening) **variables**". (Adapted from J. HOLLAND, 1992, p.54)

I. STEWART explains: "Each **state** is determined by a **set** of numbers. Thinking of these as coordinates, we obtain a **multidimensional** space whose points correspond to all possible **states**" (1989, p.43).

Obviously:

1°- the phase space is an **abstract** one and
2°- it can be used to describe future possible **states** of the **object** or system, of which, of course, one and one only is to materialize at any future instant.

However:

1°- in most cases, it becomes impossible to pinpoint and predict some specific future **state** at some precise moment (as shown by **chaos theory**, or **topological dynamics**)

2°-... which does not imply that all the future **states** are totally indetermined, since **periodic** solutions may appear, implying the existence of **steady states**.

Moreover M. DUBOIS, P. ATTEN and P. BERGE state: "...the phase space... must contain the complete **information** about the **dynamics** of the considered system. Thus the precisely necessary and sufficient **parameters** should be

selected in order to determine these **dynamics**. Moreover these **parameters** must be independent if each one is to contribute its own **information**. This implies that, if one of them is not determined, a **degree of freedom** will subsist in the determination of the considered **states**...

"... the number of these **degrees of freedom** is of paramount importance in the appearance and for the characteristic of **chaotic behaviour**" (1987, p.194).

The conservative (or **Hamiltonian**) systems are those in which the phase space is closely restricted, while still able to contain different **trajectories**.

An interesting comment by P. BERGÉ, Y. PO-
MEAU and Ch. VIDAL is that: "If we arbitrarily increase the number of **degrees of freedom**, we can always include a **dissipative system** within more extended **Hamiltonian system**, of which it thus becomes a 'part'" (1984, p.23).

This comment reflects in a new way the unavoidable dependence of any system from some **meta-** or **supra-system**, which obeys the **2d. Principle of Thermodynamics**, but altogether, the growing **degrees of freedom** obtained from **complexity**.

D. BOHM and F.D. PEAT describe phases space in relation to a **whirl** (or **vortex**): "Imagine an irregular and changing whirlpool that fluctuates in a very complex way, but always remains within a certain region of the river... As the velocity of the river increases, this variation in **space** may grow. But in addition, there will also be an inward **growth** of subvortices of ever finer nature. Therefore, a measure of the overall **range of variation** of the whirlpool should include both of these factors – the inward and the outward **growth**... As a matter of fact, in classical mechanics, a natural measure of this kind has already been worked out. Its technical name is phases space and its measure is determined by multiplying the **range of variation** of position and the **range of variation** in momentum. The former... corresponds roughly to the **changes** in location of the **vortex** as it spreads out into the river... (and) the latter... to the extent to which the whirlpool is excited internally so that it breaks into finer and finer **vortices**" (1987, p.138).

In this way, the phases space becomes partitioned into "**Markovian** partitions" (I. SINAI, 1992, p.85)

It becomes obvious that incipient **chaos** conditions result of a growing energizing of the **vortex** and begins with the **emergence** of a finer **structuration** of the phases space.

This is consistent with Ch. LAVILLE's theory of **vortices** (1950).

2547

PHASES TRAJECTORY²⁾

A curve representing the **transformations** of an **oscillating** system within its **phases space**.

In the case of **complex systems** with various independent **initial conditions**, many future trajectories are possible (and quite unpredictable). In **chaotic systems**, the trajectory becomes totally unpredictable, even in the **short term**.

2548

PHENOME^{1) - 4) - 5)}

"The set of global properties of a system in adult **state**" (Adapted from M. BUNGE, 1979, p.100).

This concept originates in biology and physiology.

BUNGE comments: "... while every **organism** inherits its **genome**, it evolves its own **phenome** in a given **environment**: the phenome depends then upon the **genome** and its **environment**" (p.101).

The phenome reflects **adaptiveness** in systems. It would be interesting to find out if **sociosystems** acquire a phenome, and how.

→ **Phenotype**

2549

PHENOMENA³⁾

The **perceptions** we obtain from reality in itself.

The Kantian *Ding an sich* is never directly accessible to us. It corresponds to KORZYBSKI's "territory".

In BATESON's words: "The territory never gets in at all... Always the **process of representation** will filter it out so that the mental world is only **maps of maps of maps**, ad infinitum. All 'phenomena' are literally 'appearances'" (1973, p.429).

In this sense, what **General Systems Research** is trying to do is merely to find out very general and coherent **patterns** for **isomorphic representation** between the complex **phenomena** that we call systems at different **levels of complexity** (see for example A KORZYBSKI's "**structural differential**" and J. MILLER's **taxonomy of living systems**).

R. FUENMAYOR interestingly describes **phenomena** as "**distinctions** made on a **background**"

The crux of the matter is of course, who makes the distinctions and on the base of which frame of reference, or theory.

2550

PHENOMENOLOGICAL POSITION³⁾

A philosophical position which concedes primacy to the **observer's mental processes** (R. RODRIGUEZ ULLOA, 1994, p. 143)

This position contrasts with the **positivist** one that accepts the possibility of knowing **reality** through experimental evidence without taking in account any influence of the **observer** on the observed **phenomenon**.

→ **Coupling (structural); Objectivity; Observer**

2551

PHENOMENOLOGICAL STANCE³⁾

"A philosophical position characterized by a readiness to concede primacy to the mental **processes** of **observers** rather than to the external world" (R. RODRIGUEZ ULLOA, Glossary, 1999)

"This contrasts with a **positivist stance**" (Ibid)

The phenomenological stance is implicit in the **2nd order cybernetics**, the **constructivist** movement and the **autopoietic** concepts of **recursivity**, **self-closure** and **autonomy**.

2552

PHENOMENOLOGY in systemic sense³⁾

A non-philosophical, but systemic sense could be given to phenomenology, i.e. the systemic way to observe **phenomena**, and more specially complex **processes** and systems.

In such a worldview, there is a conscious "perceptive intentionality" (BRENTANO, MERLEAU PONTY), different from the somewhat naive supposedly "**objective**" view and the merely **reductionist** one.

The physiological **limits to perception**, **Gestalt** psychology, GIBSON's **affordance**, WATZLAWICZ's and von GLASERSFELD's **constructivism**, WARFIELD's **methodology** for avoiding **underconceptualization**, MATURANA and VARELA's **organizational closure**, VALLÉE's **epistemo-praxeology**, for example provide good foundations for a systemic phenomenology.

The general idea would be to complement **analytic** and **holistic observation** and **modelization** of whatever we perceive, obtaining in this way a more complete and complex, and less naive view of what we call reality.

In fact, it must be admitted that the various **concepts** of what phenomenology means and implies form a quite mystifying labyrinth. From HUSSERL to HEIDEGGER, MERLEAU PONTY and various mainly German and French philosophers, the shades of **meaning** on the subject are so distinct that a coherent view is very difficult to gather.

The Danish author O. Fogh KIRKEBY has given recently a very interesting and embracing overview on this matter. He connects also to phenomenology some significant views of WITTGENSTEIN, MATURANA and LUHMANN (1997, p. 3-33)

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

2553

PHENOMENON (Aleatory) (or random)→ **Aleatory phenomenon**

2554

PHENOMENON (Model building of a)²⁾ – 3)

J.W. SUTHERLAND describes as follows the four analytical **levels** on which **systems analysis** can proceed to construct a more or less complete model of a phenomenon:

“ – The **state-variable level**, which finds us trying to exhaust the **array** of **structural** properties (i.e., major qualitative or static aspects) of the entity under investigation.

“ – The **parametric level**, where we try to assign some specific quantitative or categorical value to the **state-variables**, with respect to a specific point in **time** and **real space**.

“ – The **relational level**, which asks that we establish the nature of the **interrelationships** among the **state-variables** and the direction of influence (as in static comparative analysis in macro-economics).

“ – The **coefficient level**, which involves the assignment of a specific value to the relational **variables** which expresses the '**magnitude**' of the **interrelationships** among the **state-variables** at a specific point in **time** and **space**' (1973, p.144).

According to SUTHERLAND, "... a system will be **inherently deterministic** or **inherently stochastic**" (p.145). Since he wrote these lines, it as become clear that many systems are **inherently deterministic-stochastic** in the sense defined by **chaos theory**. Thus, SUTHERLAND's methodological **description** is irrestrictly valid only when applied to **linear phenomena**, but cannot be applied fully to modelize **complex systems**.

2555

PHENOTYPE¹⁾

The **set** of the observable characteristics of an **organism** as it results from the influence of the **environment** upon its genetic make-up (**genotype**).

The phenotype reflects the adaptive leeway of the **organism** in relation to the **environment**, but within the **limits** of the **constraints** imposed by the inherited **genotype**. The phenotypic **adaptation** may be due for instance to **ecological** factors (drought, strong winds, intense cold, high altitude), or **ethological** ones (invention of a new **behavior**)

→ **Phenome**

2556

PEROMONE^{4/5)}

Any chemical substance secreted by an organism that can affect or even control another **organism's behavior**.

Pheromones can attract males to females; evoke reactions of vigilance, aggression or fear; delimit territories or establish trails and tracks

Pheromones are a very basic factor leading to **collective behavior** and social **organization** in animals, through repeated reciprocal **stimulation**, that can be observed in social insects and vertebrates

In humans, pheromones are largely superseded by the use of gestural and spoken **languages**. They still seem however to exert a subtle influence on our behavior.

→ **Crowding effects; Dictyostelium discoideum; Societal order parameters; Sociality; Sociogenesis; Swarm**

2557

PHONEMES⁵⁾

"The smallest sound units that can change **meaning** in a **language**" (J.Z. YOUNG, 1974, p.297).

Basically, phonemes acquire **meaning values** only by combinations which each other, according to a specific **set of rules**: this is why a **language** may be considered as a system.

J.Z. YOUNG gives as examples the vowel i or the consonants b or t.

It should be noted that, in some **languages**, there are more phonemes than letters in the **alphabet**. An example are the French sounds, unknown in English, corresponding to the nasal sounds "an", "in", "on", "un", or vowels like "eu".

The same letter may represent different phonemes in different **languages**, as for example "u" in English, as compared with "u" in French or in Dutch, or "u" in German, Italian, Spanish and Portuguese.

2558

PHYLOGENESIS^{1/5)}

The ways of **evolution** of species.

The study of phylogenesis in living species started with Ch. DARWIN (1845-1912) (and his contemporary R. WALLACE (1823-1913)

It constantly evolved until our days, becoming connected with **ecology**, **ethology**, genetics and **populations** genetics and a host of other disciplines

An entirely new line of research appeared during the last 20 years of 20th Century through the study of artificial **neural networks**, **evolutionary robotics**, **parallel distributed processing**, etc. This new field is also known as **artificial life** and seeks to find out a general theory of **evolution of adaptive systems** of all kinds

2559

PHYLOGENY⁵⁾

The evolutionary **development** of any species of plant or animal.

This term was introduced in 1874 by the german biologist HAECKEL (1834-1919) According to him, the individual construction of any living being retraces, at the successive **stages** of the embryonic development, the basic characteristics of the embryos of the species from which it evolved: In a (too) short synthesis, **ontogeny** repeats phylogeny.

→ **Embryogenesis; Ontogenesis**

2560

PHYSIONICS

→ **Bionics**

2561

PLANET as a SYSTEM¹⁾

A. LOTKA introduced the idea to consider our planet as a **whole**, as a global system (although using a vocabulary of mecanicist style); "The great world engine – in which each of us is a most insignificant little wheel – has its **energy source**, its firebox, so to speak, in the sun" (1956, p.331).

This is more than a mere **metaphor**. LOTKA dedicates a significant part of his "Elements of mathematical biology" to the study of energetic exchanges between the atmosphere, the lithosphere and the hydrosphere and describes, in an explicite way the living beings as a **whole** (biosphere) or a unified system of coupled **transformers of energy**, tending towards its maximal possible use, in connexion with the planet system.

LOTKA has been indeed a precursor of LOVELOCK's GAIA's idea and of PRIGOGINE's **thermodynamics of dissipative systems**.

2562

PLANNING¹⁾

" The act or **process** of deciding in advance what to do" (UNESCO – UNEP, 1983, p.20).

The UNESCO – UNEP "Glossary of environmental educational terms" adds the following complementary definitions: "A dynamic effort to use **decisions** to guide future **actions** and **decisions**. A continuous **process** which identifies, analyzes, decides **goals/ends**, alternatives, **programmes**, and **evaluations** in guiding the future and in coming up with solutions for present and future problems" (Ibid).

The basic postulate for planning is the possibility of **prediction**. However, **prediction** remains still more of an art than a science. Moreover, it becomes now clear that **predictability** is never total and more and more imperfect for **situations** and systems **transformations** more distant in **time**.

Planning also implies **choice**, i.e. the **selection** of preferred **constraints** on the future.

The scope of planning is becoming wider and wider with the ever growing **interactions** of numerous **complex systems**. It has also become divided in more specific areas, as for example tactical and strategic planning.

The need to differentiate **short, median and long-term** planning is also more and more recognized.

In synthesis, planning is an ever wider embracing activity and thus systemic **methods** are in growing need.

2563

PLANNING: A systemic-cybernetic view ¹⁾

Efficient planning requires some conditions which are not frequently respected:

- a **knowledge** as complete as possible of the system or **organization** whose **transformation** is sought, i.e. a good **understanding** of the **interrelations** between **subsystems** and ongoing **processes**
- the **understanding** that **linear** solutions cannot work satisfactorily for long **time** in **complex nonlinear systems**.
- a sufficient **knowledge** of the **environment-system correlations**
- the **understanding** of the **stability** and **metastability** conditions to which **complex systems** are submitted, as well as the possibility of unforeseen (**chaotic**) **behavior**.
- a good estimation of the **limits to forecasting** and of the probability of wider **deviations** with **time**, with, if possible, an **evaluation** of such possible **deviations**.

St. BEER expresses forcefully the following cybernetic view of planning: "Planning should be continuous and adaptive. Societary plans should continuously abort, and be recast, before they give birth to a monster. If this is true, there is no need to base them on the **predictions** that no-one can correctly make in any case, but only on the analysis of an unfolding **situation** in which every **decision** constrains future **variety**. In that statement the unpopular notion of planning is turned on its head, and deserves to become popular again... We can make, rather than prophesy, the future" (1974, p.91).

Of course we would be able to "make" a satisfactory future (i.e. acceptable for everybody) only if we avoid a number of traps, as for example authoritarianism, ideological biases, **underconceptualization**, and even the ignorance of our own ignorance about the deeper reason of an unsatisfactory **situation** that we seek to better.

E. JANTSCH proposed two basic **rules** for purposeful **organization** or planning, corresponding to the above conditions: "1) Make **structures** as flexible as possible, so that it can be changed by emergent **changes** in the

interaction of processes; and 2) identify and enhance evolutionary **processes** of **change**, recognize and respect their self-bounding nature" (1976, p.63).

Shortly, wishful, authoritative and rigid attitudes in planning should be avoided, as well as *unwarranted* simplifications.

This implies however a question mark about *warranted* ones. G. VICKERS stated: "Some simplification there must be, and therewith much exclusion and distortion". We thus need **criteria** for satisfactory simplification as, "The more crudely simplified the **objective** the more efficiently it is likely to be pursued" (1967, p. 65).

However, trading global **fitness** for unilateral **efficiency** becomes more than once a devilish pact, whose future **cost** may be high and bitter, as already proven in many cases.

See: **Approach (The ten commandments of the systemic)**.

2564

PLANNING (Anticipatory) ¹⁾

"A planning **process** which attempts to foresee potential problems and to develop solutions to them before they become real, current problems" (UNESCO - UNEP, 1983, p.20).

Anticipation depends on **predictability**, which is always imperfect, and more so for complex **situations** and systems - whose **complexity** is frequently underestimated (see above and below).

W.D. GROSSMANN and K.E.F. WATT offer the following proposals for a "planning branch unit" in government:

"A. ... (Would) function as a continuous monitor of the institution (i.e. the Government), its activities and its **environment**, looking for... strategic errors... and determining (needed) corrections...

"B. ... foster, facilitate and expedite the free **flow of information** ... (with the possibility that) anyone inside or outside the institution could seek an audience with this unit, to point out... a potential treat they have noticed...

"C. ... (manage) innovative **structural** changes in **organization**, or **activity** within the institution...

"D. ... act as a self-corrective unit which would be constantly asking and following questions... inviting people both inside and outside the institution to offer their views" (1992, p.12).

2565

PLANNING (Generic and General) ¹⁾

J. WARFIELD states that "Planning for isolated entities in (complex) societies is becoming more and more unrealistic, in the face of **interactions** that cut across **domains** once viewed as relatively independent. In recognition of this

situation, the question of how to change planning to make it more responsive to the new **complexities** has become very timely...

"In recognition of the broad nature of the challenge to improve planning so that it can span interdependent **domains**, it is appropriate to work from a comprehensive and fundamental perspective. With such a perspective, the future of planning might be thought to depend on documented research. The research might be thought to require a theoretical component, an empirical component, and an **integration** of the theoretical with the empirical. A further condition might be imposed that rigorous **criteria** would be applied to the **integration** and that quality **control** might be exercised through the continuous **assessment** of any science of **design** that might be proposed as well as to the application of such a science.

"The concept of *generic planning* might be set forth as a way of distinguishing this broader view of planning from the concept of *specific planning* that might be used to describe what has typically gone on in the past. Finally the idea of *general planning* might be taken as the comprehensive name for the **integration** of generic and specific planning to form the ultimate total body concerning all planning" (1991 c, p.92).

WARFIELD's statement can be considered as a kind of general manifest about what systemic planning should try to achieve.

2566

PLANNING (Interactive) ^{2) - 4)}

"A **methodology** for solving an interrelated **set** of problems" (G.A. BRITTON & H. McCALLION, 1994, p.503).

According to these authors, widely inspired by R.L. ACKOFF's "Interactive Planning", the **methodology** includes five interconnected phases:

"**Mess** formulation: an analytical phase that results in a clear **description** of the **problems** and opportunities confronting an **organization**

"**Ends** planning (which) involves developing an idealized **design** and comparing it with the **mess** formulation to identify the gaps that need to be filled by planning

"**Means** planning (during which) alternate ways are invented to achieve the planning gaps identified during **ends** planning

"**Resource** planning (which) involves determining the **resources** that are available, the resources that are required to implement the **means** plan, comparing the **resources** required with the available **resources** to identify the **resource** gap, inventing and evaluating alternative ways to meet the **resource** gap, and selecting an appropriate **resource** plan.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"Implement **means**: the last phase, to identify the tasks required to implement the **means** plan, to assign these people for execution, and to **design** and establish a **control** system to **monitor** and **control** the execution" (p.504).

"The **purpose** of interactive planning is to enable the **stakeholders** of an **organization** to progress more rapidly toward the ideal of *omni-competence*. The idealized **design** of the **organization** should be more **adaptive** and better at **learning** than the existing **organization**" (Ibid).

ACKOFF insists on three basic needs to enable interactive planning:

- 1) A multidimensional **organization** with three basic ones: **inputs (resources)**; **outputs** (products and services) and market (customers)
- 2) A circular organizational **structure** which "prescribes how the **hierarchical command structure** can operate to facilitate participative **planning** and **decision-making**"
- 3) A responsive **decision** system to "prescribe the essential properties of a stand-alone system to **control** the implementation of **decisions** and how a **set** of these can be interlinked **recursively**" (p.505).

(For very important developments, see reference).

There are of course some question marks, as for example: – Who defines who are the **stakeholders**

- Where and when are the **interactions** of the organization with its **environment** (e.g. impact of new technologies, ecological problems) discussed, if at all ?)
- How and when are the views and proposals submitted to critique, and by whom (What is, for instance, an "idealized" design ? Who defines what is "ideal", for whom, under which **criteria**?)

M.C. JACKSON offers a complementary viewpoint from a different perspective: "Three principles underpin interactive planning... The first is that the **process** of planning is more important than the actual plan produced. It is through involvement in the planning that **stakeholders** come to understand the **organization** and the **role** they can play in it... All those who are affected by planning should be involved in it...

"The second principle is that of continuity. The **values** of **stakeholders** will change over time, and this will necessitate corresponding **changes** in plans. Also unexpected **events** will occur... No plan can predict everything in advance, so plans, under the principle of **continuity**, should be constantly revised...

"The final principle is the **holistic**; we should plan simultaneously and interdependently for as many **parts** and **levels** of the system as possible. This can be split into a principle of **coordination**, which states that units at the same **level** should plan together and at the same time (because it is the **interactions** be-

tween units that give rise to most **problems**), and a principle of **integration**, which insists that units at different **levels** plan simultaneously and together (because decisions at one **level** will usually have **effects** at other **levels** as well" (1992, p.147).

BRITTON suggested integrating interactive planning with BEER's **viable system model**, that could be used for **diagnosis** and **design** purpose. The **methodology** could also be combined with J. WARFIELD's **Generic Design, Generic Planning** and **Interactive Management**, which include techniques to avoid "**underconceptualization**", i. e. narrowness of **perception** and **understanding** of complex **situations** features.

According to WARFIELD the successive planning phases should be:

1. Approach to issue, on base of triggering and generic questions, using **Nominal Group Technique** and **Interpretive Structural Modeling**.
2. **Issue** exploration.
3. **Issue** definition (using the same techniques)
4. **Design** of alternatives (again using the same techniques, with triggering and generic questions)
5. **Choice** of alternative (still in the same way)

This secures that, as much as possible, nothing is taken for granted and that the participants do not remain stuck in uncriticized assumptions.

As a group **process** in which an ideal future of a system is **designed**, interactive planning is a specific application of **participative design**.

J. JOHANNESSEN states: "The basic idea of interactive planning is that the **environment** of the **organization** does not exist as given **objects**, but is created as an integrated **process** from various systems. The **organization** can choose between taking part in this **process** or passively adapting to the **environment**. The first angle of incidence is active and creative. The second one is passive and **adaptive**" (1991, p.46).

According to RAVN, as quoted by JOHANNESSEN: "Interactive planning is a **method** for breaking down mechanistic and bureaucratic social **structures**, and bringing out human and social potential in a new and more refined way".

Interactive planning implies the participation of every interested people or **group**, each of whom can bring into the **process** specific **knowledge**, **models**, **viewpoints** and **methods**.

It is necessarily a dynamic **process**, since it must take in account continuous **change** in the **environment** and also in the personal needs, motives and **information** of the participants.

JOHANNESSEN proposes an interesting use of J. MILLER's **taxonomy of living systems** as base for the construction of a **matrix of interactions** between the different **roles** of the participants within the **organization**. Such a cou-

pling **matrix** is quite useful to discover "who is who" and "who does what", thus producing a most complete view of how **structures** and **processes** are associated to people. Such a knowledge of the **organization** is basic before launching any **process** of interactive planning.

2567

PLANNING (Recursive)¹⁾ – 2)

The **process** of submitting any plan to frequent revisions.

There are at least three reasons to admit the necessity of frequently revising a plan on the march:

- Any plan is based on a simplified view of reality, based on **criteria** that may turn doubtful or unsatisfactory with **time**.
- In complex **situations** and systems, the multiplicity of **initial conditions** introduces the possibility of **deterministic chaos**, which implies that the system may not be as manageable as initially believed, or that it should be managed differently, after better **evaluation** of dominant and secondary conditions.
- The initial or subsequent results of steps already taken should be evaluated, in order to avoid surprising possible side-effects and **deviations**.

2568

PLAUSIBILITY³⁾

"...a speaker's degree of belief or confidence in a statement, given the available evidence" (W.H. JEFFERYS & J.O. BERGER, 1992, p.66)

Plausibility is a subjective **evaluation**, not a statistical one. When this latter cannot be obtained because no experimental trials are possible, the **Bayesian** concept of **probability** is useful, as for example in **forecasting** or for **evaluation** of non-verifiable hypothesis.

2569

PLAYER (von NEUMANN's): a critical view²⁾

G. BATESON writes: "The 'player' of a von Neumannian **game** is a mathematical fiction, comparable to the Euclidian straight line in geometry or the Newtonian particle in physics. By definition, the player is capable of all computations necessary to solve whatever problems the **events** of the **game** may present; he is incapable of not performing these computations whenever they are appropriate; he always obeys the findings of his computations. Such a player receives **information** from the **events** of the **game** and acts appropriately upon that **information**...

"... in von NEUMANN's formal definition of a 'game' all problems which the **game** may present are conceived as computable, i.e., while the **game** may contain problems and **information** of many different **logical types**, the **hierarchy** of these types is strictly finite" (1973, p.255).

Most important of all "The player in incapable of 'error'... , he is by definition incapable of '**learning by trial and error**'" (p.256), which shows him (it!) as a perfectly **programed automata** and thus a poor **model** of very complex real systems (including artificial ones like neural computers, of which it has been said that they are "very difficult to program").

2570

PLURALISM (Methodological)

→ Methodological Pluralism

2571

PLURIPOTENCE¹⁾³⁾

The original term used by the german biologist H. DRIESCH to name the embryonic property also known (in a more general acceptance) "**equipotentiality**"

2572

POIESIS¹⁾²⁾³⁾

The **production** and **reproduction** of internal **structures** within a system.

This is properly the whole activity of the system as considered by the **autopoietic theory** of MATURANA and VARELA.

The internal structures are either biological or neurological. At the human **level** the **self-reproducing** body is the sine qua non condition for the creation of **information**, i.e. the well-connected and evolving **frames of references**.

2573

POINCARÉ Section⁵⁾

A **method** "of reducing the study of **continuous time** systems (**flows**) to the study of an associated **discrete** time system (**map**)" (S. WIGGINS, 1988, p.67).

J. GLEICK explains this mathematical technique as follows: "The technique reduces a three-dimensional picture to two dimensions. Each time the **trajectory** passes through a plane, it marks a point, and gradually a minutely detailed **pattern** emerges" (1987, p.143).

The same technique may be applied to more complex systems, i.e., with a higher number of initial independent conditions.

WIGGINS emphasizes: "In lower dimensional problems (say dimension <4) numerically computed POINCARÉ maps provide an insightful and striking display of the global **dynamics** of a system" (p.67).

In this way, it becomes possible to gather an understandable picture of any **attractor**, be it common or strange. POINCARÉ's method is also related to the **ergodic** relation.

P. BERGÉ, Y. POMEAU and Ch. VIDAL state: "... POINCARÉ's section leads to the replacement of the **description** of some **evolution continuous in time** by an application at **discrete intervals of time**."

Moreover: "...POINCARÉ's section presents the same type of **topological** properties as the **flow** of which it is born, because of its mode of construction... If the **flow** passes an **attractor**, the structural characteristics of the same will be found in the POINCARÉ section" (1984, p.67).

Thus, this **method** makes quite easier the study of the different types of **stabilities** and **instabilities**.

2574

POISSON DISTRIBUTION²⁾

A sharply single peaked probabilities distribution **function**, which is a good **description** of the results of repeated **random** experiments of some kind.

Such distribution is observed only if the successive experiences are not **correlated** or at least not strongly correlated, i.e. cannot notably influence each other.

Very significantly, in complex systems, in I. PRIGOGINE's words: "Only **fluctuations** of sufficiently small dimensions obey POISSON statistics. This is a very important result because it implies that, conversely, only **fluctuations** of a sufficient extension can attain enough importance to compromise the **stability** of the **macroscopic state** considered" (1976, p.117).

2575

POLARIZATION¹⁾²⁾⁴⁾⁵⁾

"A concentration of **groups**, forces or interests, about two conflicting or contrasting positions" (Am. Her.Dict., p. 1014)

Polarization is a very general **phenomenon** from physics to social sciences (in this case in a more or less **metaphorical** sense)

It corresponds to the presence of two different **attractors** whose respective **fields** interact.

2576

POLICY making in systemic terms^{1) - 4)}

"A set of principles laid out for the purpose of **regulating** simultaneously and in a viable **mode** a multitude of interacting **relationships** pertaining to many qualities and dimensions of human life" (E. JANTSCH, 1975, p.6).

This definition by JANTSCH puts in a crude light the shortcomings of what is generally meant by "policy" (and politics!). As to JANTSCH "viable **mode**", let us observe that defining this is not easy and implies a very

deep **knowledge** of the various and variable ways systems are working. Such **knowledge** is moreover, by necessity, forever incomplete. **Regulations** should thus, as expressed by JANTSCH, be evolutive. This supposes an ever-more conscious and not contradictory **design process**.

Moreover the **concept** of **regulation** already implies the presupposition that the considered system is **homeostatic**, i.e. maintaining the permanence of its **structural** and **functional** characteristics. It is now well known that many **complex systems** – and mostly human ones – are **dissipative**, **chaotic** and **emergent**, and thus cannot be stabilized until they reach a new **dynamic equilibrium** condition. Unfortunately, **deciders** are generally unaware of this and pay no heed to it.

J. WARFIELD studies policy making in an extensive way (1988, p.89-118). His subjects of interest are:

- A census and critical appraisal on traditional ways of policy making;
- The nature of policy making;
- The **stakeholders** in policy;
- Policy **evaluation**;
- **Methods** for studying policy making;
- **Constraints** on policy making;
- The concept of metapolicy, i.e. "policy about how to make policy" (Quoted from Y. DROR)

The subject has also been interestingly explored by P.M. ALLEN et al. (1984) and by W.D. GROSSMANN and K.E.F. WATT (1992).

2577

POLISH SYSTEMS SOCIETY¹⁾

This national systems society has been created in 1995 by a group of polish systemists at the Technical University of Wroclaw, under the leadership of Prof. Mieczyslaw BAZEWCZ.

The objectives of the PSS include "inspiration, support and providing of systems research and inquiry, formation and development of systems education and culture, creation and development of systems methodology with an interdisciplinary scope, as well as the popularization of a wide-conceived systems knowledge".

This programme is exposed in details in the first issue of the Journal "Systems" (Journal of Transdisciplinary Systems Sciences) whose publication was also started in 1996.

The Polish Systems Society is affiliated to the International Federation of Systems Research. It established a network of collaborators in quite a number of countries in Europe, North and South America and East Asia.

The editorial office of the journal is: Oficyna Wydawnicza Politechniki Wroclawskiej, 50-370 Wroclaw, Wybrzeze Wyspianskiego 27, Poland

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2578

POLITICS⁴⁾

The government of human **organizations**.

From a systemic viewpoint, it is important to understand *how* **organizations** do manage to sustain themselves, how they define **goals** and pursue them. This however also implies a study of how some individuals or **groups** become dominant and more or less succeed in managing and controlling an **organization**.

As to the first aspect, the need for **critical subsystems** – twenty of them, according to J.G. MILLER – corresponds to the various **processes** needed to secure the **survival** of the system within its **environment**. Each **subsystem** must have definite capabilities, act in a coherent way and coordinate its **action** with other **subsystems**. It must thus obtain specific **inputs** of **matter**, **energy** and/or **information**, be able to use them and to produce some **outputs**, either products required by the system itself or by its **environment** (including **co-systems**), or unwanted subproducts that must be somehow eliminated in a non dangerous way. Politics in this aspect, is a matter of securing these conditions by appropriate, i.e. non self-defeating, **regulations** and **controls**.

The study of the ways some individuals or **groups** succeed in obtaining and maintaining the “**control** of the **controls**” and eventually loose it, as well as the **relations** they maintain with other **groups** and the way power is traded and transmitted through **time**, should form the core of the systemic-cybernetic study of politics.

Many systemic-cybernetic **concepts** could be used: **theory of communication** (including **semantic coding**, **channels capacity**, **noise**, use of **redundancy**); **theory of regulation** and **control** at multiple **hierarchical levels**; **hierarchical organization**; concept of **order parameters**, **slaving principle**; **values** and **norms**; **mindscapes**; **organizational closure**; **stigmery**; etc...

This is still largely an unexplored field, notwithstanding the efforts of K. DEUTSCH (1961, etc.), D. EASTON (1965a, b), W. BUCKLEY (1968) and some few others.

2579

POLYCENTRISM^{2/4)}

A form of extended lax **organization** connecting various local ordering centers that coexist in a common global **environment**

The present coexistence of various **socio-cultural systems** within the global **man-plan-et system** in the making could be an example

→ **Graph**; **Hexagonal space filling**; **Multi-stat**; **Node**; **Structure (Dissipative)**

2580

POLYETHISM^{4) – 5)}

The presence of different classes of ethological **roles** in social insects.

This term has been introduced by J. WEIR in 1958. According to E.O. WILSON, polyethism is one of the main factor explaining the considerable success of social insects (1971).

In social insects, it leads to **polymorphism** (sometimes reversible).

Polyethism is still more obvious and important in human societies. It may be interpreted as a kind of collective internalization of **adaptation** to **environmental** necessities.

It is doubtless a condition for **socialization**, as it connects the need for social **variety** with individual differentiation.

B. CORBARA and A. DROGOU observe that polyethism is more or less correlated to age, and can be considered as an **emerging phenomenon** (1992, p.832-834). Polyethism is more differentiated in more complex societies.

2581

POLYFUNCTIONALITY^{1) – 2)}

The characteristic of any **element** included in different **structures**.

G.S. SCUR uses the **concept** in linguistics, where it could be more specifically called “**polysemy**” (1965, p.98).

It seems however more general. A person, for example, is generally polyfunctional, as a worker, as a parent, as a consumer, as a hobbyist, etc...

Polyfunctionality can obviously be a cause of tension within **organizations**, that must harmonize and optimize the many times divergent **objectives** of their members.

It also can be a serious problem for the individual, who must reconcile into a global system of **behavior**, **objectives** that may be quite divergent, if not downright contradictory.

2582

POLYMORPHISM^{1) – 5)}

The occurrence of different basic characters, forms or types in a **population**.

The concept comes from **population** genetics, but has a more general scope.

Polymorphism may be transient when the **environment** acts as a **filter** and eliminates some variants. It may be permanent if some **variety** is necessary for a better global **adaptation** of the **population** to a fluctuating **environment**.

According to R. LEVINS: “Polymorphism contributes to the **fitness** in two distinct ways. If the **environment heterogeneity** is large compared to the **tolerance** of the individual (if the **environment** consists of several discrete **niches**, in which different **phenotypes** are optimal, or if it is distributed bimodally about **modes** which are sufficiently far apart com-

pared to the **tolerance**), a certain **phenotypic heterogeneity** is advantageous as a ‘mixed strategy’ in conditions of temporal **fluctuations**.

“Regardless of whether this first type of polymorphism is desirable, genetic **heterogeneity** is necessary for any **response** to **selection**. The **response** to **selection** is advantageous if the **environment** is sufficiently strongly auto-correlated” (1961, p.38).

Polymorphism guarantees that at least some individuals in a population will adapt even to strong environmental variations. It corresponds to ASHBY’s **variety**.

The suppression of polymorphism as for example in excessive **selection** in plants, leading to mono-cultivation, may be risky. Inversely, the existence of polymorphism, for instance in a population of pests, explains the progressive appearance of varieties resistant to chemicals.

Conditions analogous to polymorphism also seem to exist in animal **behavior** and in human social and cultural life.

→ **Diversity**

2583

POLYSEMY^{1) – 3)}

The multiplicity of shades of **meaning** that any word may take within the **semantic space** of a **language**.

Words, just like electrons, atoms, molecules, **cells** and individuals, acquire a different **positional value** within different **contexts**. This is a very important feature, which relativizes and at the same time enhances the value of **languages** in conveying **meanings**.

Unfortunately, polysemy is frequently used to distort **meanings** and confuse **receivers**. Many **senders** are even themselves unaware of the dubious **meanings** they do transmit.

Polysemy plays also an important role in the **evolution** of **languages** because it favours *progressive* reductions, extensions and shifts of **meanings**.

2584

POLYSEMY IN MATHEMATICS

→ **Mathematics (Polysemy in)**

2585

POPULATION¹⁾

1) The global **set** of individuals or **elements** of a same **class**, i.e. sharing defined characteristics.

A population is generally confined within a limited **space**, possibly with very different local **densities**.

While belonging to the same **class**, no individual is absolutely identical with any other: populations are generally **polymorphic**, within **limits**.

A population is not only **synchronic**, but also **diachronic** since the number of members may increase or decrease with **time**, as well as their repartition and global or local **densities**.

Populations correspond to a special type of systems, in which every element is directly and dominantly interconnected with the **environment** and only loosely and intermittently with other members of the population (see "**Scattered system**"). This type of systems does not generally possess clearly identifiable **sub-systems**.

2) "An **aggregate** of individuals conforming to a common definition, to which individuals are added (born) and subtracted (die) and in which the age of the individual is a relevant and identifiable **variable**" (K. BOULDING, 1956, p.13)

BOULDING explains: "Birth" occurs when an item begins to conform to the definition which encloses the **aggregation**, and "death" when the item ceases to conform to the definition. A definition may be thought of as closed fence: everything inside the fence belongs to the defined population; birth consists in crossing the fence into the enclosure; death in crossing the fence out of the enclosure. The population concept thus defined is a perfectly general one, and applies not only to human or animal populations, but to populations of automobiles, poems, stars, dollars, ideas, or anything that is capable of definition" (1956, p.67).

In any system that can be described as a population, internal and external **interactions** can be considered in terms of **competition**, **complementarity**, **parasitism** or **symbiosis** "whether the species consist of animals, commodities, social classes or molecules" (ibid, p.13).

3) A generalized and more abstract definition of population is given by T.A. and W. MILLINGTON: "The whole **set** of items which have a common characteristic, which is subject of some sampling in the **process** of statistical analysis" (1971, p.182).

Along this line, populations can be sampled, i.e. an appropriate (and frequently numerically quite limited) **subset** can be studied for some specific characteristics, in view to obtain generalizations by the use of convenient statistical **methods**.

Samples are however referred to a specific moment in **time**. As a result, any dynamic inquiry needs various successive samplings to study temporal **change** affecting the population.

2586

POPULATION EXPLOSIONS ¹⁾

Populations explosions are a result of a unilateral or strongly dominant **positive feedback**, which triggers a **runaway event**. This **process** normally ends in a crash.

Runaways happen when the supply of **energy** or aliments is growing in an unlimited fashion, until some critical **threshold** is crossed.

It can even happen in a more subtle way, as shown by the following experiment, described by L.B. SLOBODKIN: "If a population of green hydra is given a diet of water fleas the hydra proceed with their normal response to population **growth** and become smaller as individuals become more numerous. They become so small, in fact, that they are unable to eat the waterfleas at all and the entire population dies of starvation" (1968, p.153).

In short, the **positive feedback** tends to finally trigger a negative one, which may appear under the guise of starvation, a pandemy, a **process** of biological or **behavioral** (as for instance in lemmings) self-destruction.

One may wonder about the potential lessons for mankind in its present **process** of population explosion.

2587

POPULATION (Meta)

→ **Metapopulation**

2588

POPULATIONS (Stability of mixed) ¹⁾

Heterogeneous populations of a same species, or numerous different species within an ecological system are more stable than **homogeneous** ones.

R. MARGALEF states: "The greater the number of avenues by which **energy** may flow through a **complex system**, the stabler it is" and "... a community exhibiting great stability... is comparable to a system easily convertible within a series of equivalent systems" (1958, p.61).

MARGALEF insists on the importance of "high indices of diversity" – an idea akin to ASHBY's **variety** – and gives a number of examples in **ecosystems**.

However, the **concept** seems quite more general, as it could be applied to any kind of **networks**, as for example neural or social ones.

The number of avenues through which **energy** may flow is also reminiscent of BENARD's and PRIGOGINE's **dissipative structures**, as well as LOTKA's **model of the world engine**.

At least two different **effects** can affect the **stability** of a population:

- Over exploitation- as in the case of hunting or fishing for example, can lead to an excessive reduction of some specific population. In such cases, other species can invade the **niche** left more or less vacant and the species cannot anymore recuperate, or even maintain itself. This may be caused by decreasing genetic **variety** or by an excessive rarefaction of individuals.

- Some strong **perturbation** in the **environment**- as for example a destructive hurricane-may have a similar **effect** by damaging the **habitat** of the species, either for some more or less extended **period**, or definitively. The subject is now considered in **ecology** through **patch-dynamics**.

2589

POSITION EFFECT

See hereafter **Positional Value**

2590

POSITIONAL VALUE ^{1) - 2)}

The value of an **element** in a system as related to its place in a global **structure**.

Back to 1941, A. ANGYAL stated that: "The members of a system... do not become constituents of the system by means of their immanent qualities, but by means of their **distribution** or arrangement within the system. The **object** does not participate in the system by an inherent quality, but by its *positional value in the system*" (1969, p.20).

While fundamental, this concept should also be put into perspective: To become a **part** of a certain system, any **element** must be endowed with some intrinsic characteristics that makes it compatible with the system.

It is the case for example for the immune **compatibility** of a **cell**, or the professional, linguistic or cultural **compatibility** of an individual in an **organization**.

Moreover, the **element**, whatever its position, must be activated through a **morphogenetic** and **autopoietic differentiation process**, triggered by some few original **elements**.

→ **Autogenetic systems precursors and Zero system** (V. CSANYI).

2591

POSITIVISM ³⁾

"The belief that the only qualities of systems which are real or meaningful are those which can be directly measured" (R. ROSEN, 1979, p.175).

This is R. ROSEN's systemic definition of positivism, that he comments in the following way: "Invariably such a belief is coupled with an extremely narrow view as to what in fact constitutes a **measurement** or **observation**, and leads inexorably to an assertion that whatever falls outside this narrow framework does not exist. Worst of all, an exclusively empirical approach gives rise to an utterly false **dichotomy** between "experiment" and "theory", which has done boundless mischief in the world..." (ibid).

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

2592

POSITIVISM (Neurological)³

A theory about the ways world, **brain** and mind are homologously linked.

This interesting **epistemological** view has been introduced by L. R. VANDERVERT (1988, p.313-21)

"Neurological positivism asserts that nervous systems *project* their order onto the **environment** to extract **invariance**. This neurological-level projective **process** is father (**homologically** speaking) to all knowing... and to all **cognitive-level** projection which is a part of the literature of personality psychology. **Knowledge** is a **category** of evolving **invariance** which arises as the result of the projection of the neurological **order**" (p.317).

VANDERVERT inspired himself from LASZLO's **information flow loop** "which include the following:

"1. variant **environment**

"2. **perception input**

"3. **control coding (or coupling)** between **input** and **output** (in neurological positivism this is the neurological **order**)

"4. **output (behavior)**

"This **loop** accomplishes two things. First, it maintains invariant **steady states** in the nervous system (or in **cognition**) through **negative feedback**. Second, it **self-organizes** or adapts the system to the vagaries of the **environment** through projected or projective **positive feedback processes**" (Ibid).

VANDERVERT's views should be compared with J.J. GIBSON's **ecological perception**, BATESON's **ecology of mind**, von FOERSTER's **cybernetics of "observing systems"**, with MATURANA and VARELA's **recursivity and organizational closure** and with M. EIGEN's **hypercycle**.

2593

POSITIVIST POSITION

→ **Phenomenological position**

2594

POSITIVIST STANCE³

"A philosophical position characterized by a readiness to concede primacy to the given world as known through experimental evidence" (R. RODRIGUEZ ULLOA, Glossary, 1999)

The positivist stance dominates all classical physical sciences and also in part biology and its specialized disciplines.

It should anyhow not be forgotten that:

- Our experimental evidence is necessarily filtered by our perceptive system, itself coordinated by our **nervous system**.
- The experiences that we register or perform are conditioned by the previous education of our **perceptions** which thus become "tainted" (M. MERLEAU PONTY, 1945)

- Any scientific experiment is pre-oriented by some theoretical views that are supposed to be submitted to **confirmation** or **refutation** (POPPER)

2595

POST-CYBERNETICS GROUP in Tokyo¹⁾

This group has been created in 1992 in Tokyo by Makiko OKUYAMA, of the Ohmiya Child Health Center (2-24-1, Toro-Cho, Ohmiya-Shi, Japan 336)

It is an **interdisciplinary** group whose members come from "**management science**, **information science**, physiology, public health and psychiatry".

M. Okuyama states: "the name" post-cybernetics was used because the word "cybernetics" strongly reminds people of mechanical and engineering **feedback** systems and, besides we wanted to pursue the new meta-disciplinary **concept**, and not just to be limited to the conservative cybernetics".

More members have joined the group. "Their specialities are **artificial intelligence**, engineering, **cognitive science**, **sociology**, accounting, marketing, and so on."

The group has a monthly conversation "which includes a lecture and discussion."

The above information has been published in Cybernetics and Human Knowing, 2(3), 1994

The present situation of this Group is unknown to this editor.

2596

POWER LAWS²⁾

Similar **rules of energy** use that operate at various **levels** in a system.

Power laws occur when the average **frequency** of an **event** of a given **size** is inversely proportional to some power of its **size**. For example, small earthquakes are quite **frequent**, but much less destructive than the strong ones, which in turn are quite **less frequent**.

Systems near **critical states** seem governed by such **optimization rules** (or power laws) which minimize their expenditures of **energy**.

As a consequence, according to I. RODRIGUEZ ITURBIDE et al (in P. YAM, 1994, p.17): "Rather than emerging from **events** happening nearby or taking place immediately before, **critical catastrophes** may occur because of a global, **long term mechanism**. Specifically, the systems may be minimizing the amount of **energy** they expend in maintaining themselves, thereby optimizing the way in which they develop".

The authors created a mathematical **model** whose statistical properties are exactly the same as those of a drainage **network**, in which "the length of the stream **channels** and the distribution of **branches**, and of the **energy** at any point, all obey these (power) laws. It seems

also possible that in earthquakes **models**, tectonic plates may be organizing themselves locally so as to minimize **stress** for the entire system".

The same **model** could explain how "trees are optimizing their leaf distribution to take advantage of the light they receive".

YAM adds: "The finding raises the question of whether all **self-organized critical systems** evolve through some global principle of **energy minimization**". It also poses interesting question marks about the ways of **interactions** between particles, **elements** or **agents** which are not connected in any known functional way. We obviously need not only a **model** of global **action**, but also one of local and possibly non-local **action** in connection with the global one.

This could lead to a clearer interpretation and understanding of **holographic order** and, generally, of **implicate order** in BOHM's terms and even possibly make sense of R. SHEL-DRAKE's **morphic fields**.

Power laws seem also related to the **fractal** character of many systems. They could offer interesting insights in relation to social **organization** and quiet or violent **change**.

A connection between power laws and so called "**small worlds**" is also probable; the many frequent small connecting steps among nearby **elements** are somehow opposed to unfrequent big leaps between distant **hubs** in a **network**.

This can be observed for instance as two different ways of **propagation in epidemics**

Power laws seem also to explain some typical relations in **ecosystems** (A. FROOD, 2001, P. 30-33)

It could be said that power laws and fractalization are the two faces of the same coin.

This is also obvious in the case of WEIERSTRASS **renormalization group transformation**

→ **Self-similarity in the Weierstrass function**

2597

POWER PRINCIPLE (Maximum)^{2) - 4)}

"Natural systems tend to operate at that **efficiency** which produces a maximum power output. This **efficiency** is always less than the maximum **efficiency**" (H.T. ODUM and R.C. PINKERTON, 1955, p.331-343).

J. MILLER comments: "(Following ODUM) a major **design** principle of natural systems is **feedback** from **storage** to **energy** inflow pathways. This stimulates energetic inflow and **functions** as reward. In this way, **processes** that are doing useful work are reinforced. Such **feedback designs** are **autocatalytic**. They maximize power, *consequently generating more entropy*. **Autocatalytic processes** depend upon sufficient concentration of potential **energy** - **energy** available for doing work. If the **energy** source is weak, the system minimizes **energy flow** and **entropy** generation. The max-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

imum power principle suggest that natural **selection** operates to select systems **designs** that maximize power. Systems compete for available **energy**.

"Systems of this sort develop **hierarchies** with successive **transformations of energy** in which **energy** increases in "quality" as units increase in **size**" (1986, p.78).

ODUM discovered the principle studying **ecosystems**. It fits, however, nicely **human systems** throughout the whole technological **evolution** of mankind. The principle looks like a good explanation for the general **phenomenon of evolutive acceleration** (F. MEYER, 1954).

2598

PRACTICE and/or PRAXIS? ²⁾³⁾⁴⁾

W. Mc WHINNEY observes that these two **concepts** are quite different from each other.

He states: "Practice focuses on a habitual and systematic **process** of doing. I further stipulate that a practice follows an implicit set of **rules or theories**..." And "Practice ...follows a **program**" (1997, p. 80)

As to "Praxis", it "is the study and practices of attaining **goals**. It focuses on the goal without the confines of a limiting set of rules"...and "Praxis is a way of working beyond theory and practice, getting results beyond those available within a single **domain** of work" (Ibid).

Practice would determine for example the correct way to use a screwdriver, while praxis would define the choice of a screwdriver among various ones or even some other tool in some specific **situation**.

While this may seem at first sight somewhat far fetched, McWinney makes his point very clearly in his paper.

2599

PRACTICE in the social systems sciences ⁴⁾

R.L. ACKOFF, in a very realistic way, developed the following views about practice.

"By a **social system**, I mean a system in which people play the most critical **role**. This does not include telephone and water-supply systems, but it does include telephone companies and water-supply agencies.

"By practice I mean work for clients who have the authority to change the system worked on in ways specified by that application. I do not mean work on **problems**, however real they may be, without the direct involvement of those who are responsible for doing something about them and those who are directly affected by them – the **stakeholders** in the **problem's** solutions.

"By a theory of practice I mean a **set** of definitions and propositions from which testable hypotheses about the effectiveness of practice can be deduced. By effective practice I mean improvement in the **performance** of client or-

ganizations from the point of view of at least some of the **organizations' stakeholders**, and the absence of deterioration of that **performance** from the point of view of any.

"By a practitioner of the **social systems science** I do not mean one who, confronted by an **organization's mess**, collects symptoms, diagnoses, and prescribes as a doctor does with a patient. I mean one who, through encouragement and facilitation, enables others to deal with their **messes** more effectively than they can without his help...

"For me, practice is first and foremost an educational **process**, not only for those with whom we work, but for practitioners as well. If they don't learn through their work with others, they are not practicing, but consulting, sharing what they already know. Put in another way: the **objective** of practice is to increase the **development** of the client system, its **stakeholders**, and the practitioners engaged in that effort" (1988, p.241).

These views could deeply transform the ways of the three different "classical" types of practitioners described by ACKOFF:

"1) **Input-oriented practitioners**, ones who define themselves by the tools, techniques and **methods** they employ in solving **problems** – for ex., applied mathematicians, computer programmers, accountants and radiologists;

"2) **Output-oriented practitioners**, ones who define themselves by their product, the kind of **problems** they solve – for ex. those who develop incentive, compensation or **management information systems**, "head hunters" and cardiologists;

"3) **User-oriented practitioners**, who define themselves by the class of users they try to serve – for ex. general contractors and practitioners of general medicine" (p.246).

2600

PRACTICE (THEORY and) ^{1) – 3)}

R.L. ACKOFF asks : "Can one practice without theory and theorize without practice?" and answers as follows:

"Of course one can do both, but theory without practice (application) is **form** without **content**, and practice without theory is **content** without **form**. Practitioners should bring to their practice both a theory of practice and theories to be used *in practice* (**contextual theories**) A practitioner who has no theory of practice flounders when confronted with a new **situation**, at best muddles through. A practitioner who has no **contextual theories** is merely a **change agent** who can provide no assurance of inducing **development**" (1988, p 245).

2601

PRAGMATICS ³⁾

"The theory of the **relations** between the **signs** and their users"(D. GERNERT, 2000a) p. 156)

According to GERNERT: "From the very beginning, **pragmatic information** has been characterized by the "property to change the receiving system"(quoted from KORNWACHS and von LUCADOU, 1982) or more formally, by the property to alter **structure** and/or **behavior** of the receiving system"

He adds: "Two constituents of pragmatic information are termed "novelty" and "**confirmation**". A **message** only repeating well known stuff contains no novelty and hence no pragmatic information (here again, a comparison with syntactic **information** is worthwhile). On the other hand, a **message** in an unknown foreign **language** can bring about no impact upon a receiver -it carries no "confirmation", that is, no relation to the receiver's state of **knowledge**, predisposition, or information requirement. Pragmatic information requires both novelty and a concrete relation to the receiver's predisposition: the amount of pragmatic information will rise as novelty and/or confirmation increase"(Ibid p. 159-60)

→ **Meaning; Meaningless; Semantics (General); Semiology; Semiotics**

2602

PRAGMATISM: A systemic view ³⁾

According to the American Heritage Dictionary, philosophical pragmatism is: "The theory developed by Ch.S. PEIRCE and W. JAMES that the **meaning** of a proposition or course of action lies in its observable consequences, and that the sum of these consequences constitutes its **meaning**".

J. WARFIELD enumerates the following components of PEIRCE's pragmatism (pers.comm.):

"- **Inference** gradually leads into **habit**
"- Authority is one of the four ways of fixing belief

"- Once belief is fixed by authority, it is sustained by tenacity

"- If authority and tenacity are not the origins of belief, then two other possibilities remain: metaphysics and science

"- Metaphysics fixes belief through speculative reasoning

"- Science fixes belief through cyclic means involving investigations of questions

"- Questions are superior to assertive hypotheses as bases for scientific study.

Moreover, "Every question involves contextual implication" which "In the first instance refers to:

a) the linguistic demand places on the recipient of the question

b) the hypotheses that underlie the question" (This is obviously where the systemic view enters).

"In the second instance contextual implication refers to

a) the (implied) questions to which those hypotheses are possible answers, and

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

b) The contextual implication of the implied questions

c) the hypotheses underlying those questions... "and so on until a possible point is reached where there is no contextual implication. If such a point is reached it is in the axiomatic domain" (Ibid)

This is a typical **recursive process** which should not leave any **epistemological** stone unturned.

C.W. CHURCHMAN and R.L. ACKOFF gave a systemic interpretation of pragmatism as follows:

"a) From criticism it borrows the notion of the interplay of **observation** and concepts, though it gives neither an autonomy or fixed character.

"b) From Hegelianism it incorporates the rejection of the "certainty" of immediate sense **data**, but it denies the "primacy" of any absolute.

"c) From Hegelianism it incorporates the notion of **process** as critical to **inquiry**, but negates Hegelian idealism and metaphysics.

"d) From 19th century developments in formal and physical sciences it incorporates the rejection of the certainty of scientific laws (as expressed, for example by POINCARÉ (1857-1912), and recognizes that the *a priori*, through necessary, is selected, not given.

"e) From a development characterized by the French philosopher RENOUVIER (1815 - 1903) it accepts the notion that scientific interests cannot be separated from other human interests (e.g. morals), and that **truth** is a **function** of usefulness.

"f) From 19th century developments in psychology and British social philosophy it accepts an orientation toward **objectives**, **goals**, aims and desires.

"g) Finally, from KANT, it eventually incorporates the notion of "ideal pursuit" as a measure of progress, but unlike KANT, it seeks to treat ideals naturalistically (1950, p.194).

While the influence of "ideal pursuit" is obvious in anything C.W. CHURCHMAN has done, and in the pragmatic stand in the whole of R.L. ACKOFF's work, the systemic view is only latent in their interpretation of pragmatism, in the form of a somewhat vaguely enunciated concern for global **interconnections** between human concerns.

C.S. PEIRCE's pragmatism is possibly reflected in a stronger and truer systemic way in J.G. WARFIELD's **Generic Design Science, Interpretive Structural Modeling and Nominal Group Technique**.

2603

PRAXIOLOGY¹⁾

The science of the conditions of **efficiency** of all **action** (T. KOTARBINSKI, 1995, p.32).

KOTARBINSKI seems to have been the initiator of the praxiological studies (1965). "The Learned Society of Praxiology" of Poland (Nowy Swiat Str. 72 - 00-330 Warsaw) is now the center of these studies and publishes an "International Annual of Practical Philosophy and Methodology" whose Editor-in-chief is W. GASPARSKI

(See A. COLLEN & W. GASPARSKI, 1995)

2604

PRAXIS

→ **Practice and/or Praxis**

2605

PREADAPTATION¹⁾

The condition of a system whose already acquired characteristics makes it fit to respond satisfactorily to new future conditions.

In a narrow sense, the concept is nearly tautological, i.e. when future conditions are a normal result of the present ones, as for example in the progress of a biochemical reaction (ROSEN, 1991a, p.544).

In a broader sense, a system endowed with much **variety** may be preadapted to some **variations** in its **environment** that are of a completely new type.

The concept remains however fuzzy: Can it be said that the anopheles mosquitoes that became resistant to various insecticides were "preadapted", or possibly possessed a "potential for adaptation", whatever this may mean?

M. BUNGE introduces the curious concept of premaladaptation (1979, p.104): In this case the mosquitoes killed by insecticides would have been "premaladapted" (also somehow a tautology!)

→ **Predictor**

2606

PRECAUTIONARY PRINCIPLE

→ **Caution principle**

2607

PREDATOR (Man as a)

→ **Man as a predator**

2608

PREDATORY BEHAVIOR¹⁾²⁾⁵⁾

The **behavior** of a **living organism** that obtains the **inputs** it needs by capturing other organisms or by plundering some other environmental **resource**.

Practically all living beings eat some other living beings and are eaten by other in turn. This is one of the most basic facts of life and **ecology**.

The dynamics of the variable **interrelations** between predators and prey have been researched mainly during the 20th C. by ecologists, demographers and mathematicians.

Two very important contributors have been V. VOLTERRA (1931) and A. LOTKA (1956)

Since the 1970's the subject has been widely reconsidered because some irregularities in the evolving and interrelated **populations** sequences of preys and predators could not be clearly explained. R. MAY has been possibly the main innovator in the field, by showing that "simple mathematical **models**" can produce "very complicated **dynamics**" 1976, 1977, 1987)

In fact, these now models have widely contributed to the elaboration of **chaos** theory, and, in turn, have benefit from other developments in the same theory

→ **Dynamics (chaotic), Growth, Logistic equation**

2609

PREDICTABILITY^{1) - 2)}

The more or less relative possibility to make **forecasts** about some **process** or systems **behavior**

W.R. ASHBY stated: "One common idea, for instance is that the **brain** can predict the future. The idea certainly has a superficial **plausibility**, but is fundamentally wrong. WIENER put the truth succinctly when he said that to predict the future is to carry out an **operation** on the past. If the past shows repetitions, and if the future sustains the regularity, then the **brain** will score a hit when the future arrives. But the **process** is wholly based on past **events** and on the degree to which the real world has consistent regularities. Let the world produces something really new, and the **brain**, human or other, is helpless. What happened, for instance, to those who worked with X-rays in 1905 ? They burned themselves horribly. The **brain** cannot deal effectively with the really new: it must wait until the new has had **time** to go adequately in the past. All wisdom is after the **event**. What we expect of mechanical **brains** must be based on this fact, if our expectation is to be realistic" (1963, p.207-208).

According to F. HEYLIGHEN: "**Processes** that are predictable, but not reversible are characterized by the fact that **distinctions cannot be created** (i.e. distinct effects always result from distinct causes),... **but can be destroyed** (i.e. distinct causes can have equal effects)" (1989, p.2369)

"**Processes** that are reversible but not predictable are characterized by the fact that **distinctions cannot be destroyed** (i.e. distinct causes always lead to distinct effects), but can be created (i.e. equal causes can have distinct effects) (Ibid.).

This abstract statement mirrors the fact that predictability is always *practically* limited. Total **reversibility** is impossible in the real world, which always allows for some measure of unpredictability. But the existence of **giant fluctuations**, with the possibility of **bifurcation** and even, in some cases, **emergence** of higher **levels of complexity** in **processes** and systems, nearly completely impedes precise predictability.

F. HEYLIGHEN adds: "From the point of view of predictability,... the microscopic **causality** principle is useless or trivial, since it ignores all repetitions of **processes** or experiments. Predictability only exists on a **macroscopic level**, where **microscopic** differences between non identical, individual **phenomena** are ignored, to determine the macroscopically meaningful **distinctions** between (infinite) **classes** of **phenomena**" (p.378).

HEYLIGHEN proceeds, giving the following example: "It is a classic result that **phenomena** that are completely unpredictable at the **microscopic level** may be modelled macroscopically by **deterministic** theories. For example, statistical mechanics shows how the **random** collisions between molecules in a gas can be described by **deterministic** equations for **macroscopic** properties such as temperature, volume and pressure. It is also well known that the **indeterminism** that quantum mechanics postulates for microscopic particles disappears when going to the "classical limit" of **macroscopic objects**" (Ibid).

Thus, there is a **degree of macro-determinism**, framing **micro-indetermination**, and **information** about it can be obtained by using statistical **methods**. (see **data reduction**)

HEYLIGHEN adds: "On the other hand, recent developments in **self-organization models** and **nonlinear thermodynamics** have attracted attention to the opposite **phenomenon**: microscopically **deterministic** systems that behave in a complete unpredictable way when considered from a **macroscopic viewpoint**" (p.378).

As an example, HEYLIGHEN cites: "... certain types of **cellular automata** whose local dynamical **rules** are completely **deterministic** but for which there is no global **algorithm**, allowing to predict their overall **evolution** without computing all the individual, microscopic **transitions** from the given **initial state**" (According to S. WOLFRAM, 1984).

There is thus a relative antinomy – or complementarity, as already noted by POINCARÉ – between **levels** and types of predictability. **Deterministic**, or **algorithmic** predictability would be rigorous, but is practically never possible (even if it may be approached in some cases). Stochastic predictability is frequently possible, but does not allow specific **prediction** for individual **events**. This became clearer with the discovery of **chaotic determinism**.

As expressed by J. CASTI: "Being **deterministic** and being predictable are just not the same thing at all" (1994, p.87).

2610

PREDICTABILITY (Asymptotic)¹⁾

J. BRIGGS and F. D. PEAT characterize a special type of predictability for **quasi-periodic systems**. For such systems it is not possible to make **precise predictions**.

However, the system's **behavior** will always evolve within a specific **toric attractor**, which means that it will not evolve in a totally **random** way in the **phases space** (1991, p.41, French translation).

This is characteristic of numerous physical systems, but is also probably typical of some **sociosystems**, as for example the markets, which offer examples of **quasi-periodic cycles** shrouded in stochastic irregularities.

2611

PREDICTABILITY in chaotic systems (Limits to)^{1) – 2)}

In **strictly deterministic systems**, as stated by P. DAVIES: "...a small **input error** implies a small **output error** in the predictive computation. ...**(While) errors** accumulate with **time**... (they) grow only in proportion to the **time** (or perhaps a small power thereof...)".

However, in a chaotic system "... a small starting difference between two (*nearly*) identical systems will rapidly grow. In fact, the hallmark of **chaos** is that the motions diverge exponentially fast" (1990, p.50).

In the same fashion, in any system with three or more initial independent conditions, **sensitivity** to these **initial conditions** produces the same limits to predictability.

2612

PREDICTION^{1) – 3)}

A statement about some future **state** of a system.

Scientific prediction in the classical sense is limited in practice. It is possible only within the **frame of reference** of precise and limitative conditions.

T. BAUMGARTNER et al. give the following example: "It must be realized that the pinnacle of prediction occurs in physical mechanics and is based upon the concept of the isolated point mass, subject to forces acting at a point. These notions and the basic conservation laws permit derivation of the equations of "point mass dynamics", which can be extended to arbitrary bodies, analyzed as finite collections of point masses, through consideration of the "continuity of **matter**" and calculus. The precision with which astronomical trajectories are determined

and the guidance of spacecraft to within yards of a predetermined landing site provide striking validation of the **models** and the principles upon which they are based" (1976, p.34).

There are however many **situations**, even in physical sciences, where these postulates lead to somewhat, or grossly erroneous predictions (see for example POINCARÉ's **3-bodies problem**) or become downright useless in practice (as in LORENZ **chaotic meteorological dynamics**).

Predictions are thus heavily dependent on the alternative **models** selected to make them. As **data** relative to **processes** can be in many cases accommodated (or fudged!) to different **models** (for ex. **linear**, **logistic**, asymptotic, **exponential growth**), specially when they cover too short a span of **time**, the prediction may very well be implicitly stated within the **model**.

Moreover, biological and **social systems** offer such high degrees of **complexity** that prediction must cover not one, but an **array** of interconnected **processes**. To be *more or less* possible, prediction demand then quite more intricate **methods**.

2613

PREDICTIVE EVENT¹⁾²⁾⁴⁾

An **event** that normally precedes some other event.

The **concept** of predictive event is useful but quite ambiguous. A lightning is most generally succeeded by a thunderclap, because it is its direct **cause** and the **connection** between both is quite evident and immediate.

Some events produce however their consequences in faraway places where they may remain unknown, or after such a long **span of time** that the **perception** of any connection is lost. In some cases distance in **space** and/or time does not suppress the predictive **value** of an **observation**. B.S. ORLOVE et al. have described cases of use of predictive meteorological events made by more or less archaic populations in south America, Asia, Africa and Australia, all of these strictly based on empirical **observations** of clouds or brightness of stars (2002, p. 428-35)

On the other hand, the event becomes predictive for the **observer** who has already witnessed at least one (and better, various) similar sequences of events.

And even this is not enough if the observer has no **model** or **frame of reference** through which the observation makes sense. However, as in the case of so-called ethno-climatology, the frame of reference does not need to be an elaborated scientific **theory**.

→ **Clue; Predictability; Predictor; Prediction; Prospective**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2614

PREDICTOR²⁾

A **situation** or setting which implies up to a point some future **states** of a system.

The concept has been used by R. ROSEN, who applies it to initial concentrations of some metabolites in a biosynthetic pathway. ROSEN understands that such a setting amounts to a **preadaptation** (1991a, p.544).

In any system, the present **state**, as well as its functional nature, implies definite **limits** to possible future **transformations**. It may for instance:

- absolutely preclude some
- make some others very improbable
- make others more or less probable.
- render some others unavoidable.

While in some cases the predictor defines quite precisely the future timing (chemical reactions), in others this **prediction** remains elusive (earthquakes, economic recessions).

→ **Percolation, Power laws, System (Composite)**

2615

PREFERENCE¹⁾

The election of an alternative among others, according to some **criterion**.

K. KRIPPENDORFF observes: "Consistent preference orderings are all **transitive** (e.g. if $A > B$ and $B > C$, then $A > C$). Inconsistent preference orderings contain circularities (e.g. $A > B$, $B > C$ and $C > A$)" (1986, p.58).

In complex **situations**, preference orderings can become very tricky, as various **criteria** can be more or less contradictory or incompatible.

2616

PREFERENCES (Collective)²⁾⁴⁾

The problem of harmonization of collective preferences has been considered by K. ARROW (1956, 1963). After his mathematical **modelling** work he came to the conclusion that the only **methods** to clearly define collective preferences from individual ones, if there is a great number of individuals, is to impose them

In MORIN's words (1999b, p. 85) there is no possibility to create a good optimizing **algorithm** in any human collective **behavior**. The definition of the major good or the least evil leads to an **uncertainty** that cannot be eliminated

This reflects or course the multiplicity and **complexity** of the shifting **interactions** which take place in constantly variable ways

It sheds a dispiriting light on the **interrelations** between **cultures**. It could also explain the universal need for **values** and **norms** in defining and strengthening all kinds of social conducts (as expressed by the german term "Gleichschaltung" (= bringing into line), with its unfortunate authoritarian undertones)

But at least some help could conceivably be found in opinion inquiries and polls, even if not conclusive, nor of permanent validity.

→ **Agregation 2**

2617

PREORGANIZATION²⁾

The **set** of **initial conditions** needed in a potentially **self-organizing** system.

M.B. HAWTON (1974, p.87-8) (quoted by D.L. VELKOV – 1989, p.48-50) describes the preorganization **situation** as follows: "In the **self-organizing system** insufficient prior links exist, and the balance of **data** for immediate **control** purposes has to be generated inside the system. This may appear as if by magic, but in practice it has to come from somewhere if the laws of physics are not to be abrogated... no system can be built which is initially **self-organizing**. Initially it must have sufficient preorganization to run the first **cycle(s)**, so as to generate the **information** which will be accumulated to organize future **cycles**. A **machine** can only become **self-organizing** through **operation**".

An example could be the preexistence of the phonation capacity in the newborn, which is the first condition for the future construction of **any spoken language**.

However, preorganization must also have an origin. Thus, the **self-organization** riddle is somehow **recursive** and probably related to a **hierarchy** of **complexity levels**. The existence of **organization** at a lesser level of **complexity**, combined with specific new **environmental** opportunities and/or **constraints** may explain preorganization for a higher **complexity level**.

D.L. VELKOV also quotes H. ATLAN, according to whom "**organization** is meant either as **constraints** between **parts**, i.e. **redundancy** or non-repetitive **order**, i.e. **variety** and inhomogeneity" (Ibid).

A dynamic **mechanism** seems necessary: only **parts entering** in **interaction** generate **new constraints**, in accordance, for instance with H. SABELLI's **process theory**.

HAWTON's views should be compared with V CSANYI's **autogenetic system precursors**, **zero system** and **supercycles** formation. They are also related to the construction of M. EL-GEN's **hypercycles**.

They even may help to understand better the riddle of the relation of **autogenesis** to **auto-poiesis**.

2618

PREPROGRAMMING²⁾

The possibility, latent in systems, to construct behavioral programs.

W. ROSS ASHBY observes that the human **brain** is preprogrammed. Its **organization** is a result of former **evolution** and, at the same time it offers potentialities for more **program-**

ming through training and **learning** (which results quite probably of the progressive ordering – or eventual reordering – of **neural nets**) (1963, p.215)

Thus, the operative capability of the natural intelligent "**machine**" results of progressive **self-programming**, i.e. of the construction of **behavioral algorithms**.

It is likely that efficient high level **artificial intelligence** can be constructed only along similar lines.

2619

PRESENT (The everlasting)¹⁾³⁾

Our historical as well as our prospective **perception** of **time** are mental **constructs** based on an everlasting existential **awareness** (or non-awareness!) of living at the present moment.

What happens (to me) at this present moment is an integrated result of multiple **flows** of **events** converging into my personal perception.

The past is **memory**, i.e. also a reconstructing **phenomenon** at the present moment. So are also our future expectations, which are merely (just now) a speculative mental construct.

P. VENDRYES explained the present moment as the instance of **decision making** by the **selection** of only one **action** possibility among many. That selection precludes the possibility of any other action that we could have selected. This selection **process** is repeated at any future moment.

Another significant aspect is that every individual is enclosed in his/her own present, without any possibility to be influenced at this very moment by events occurring now to others in other places, as there is always a **time lag** in the **propagation** of **effects**.

Moreover psychical **connexions** between individuals requires- also at any present moment- **consensus** on what was and is perceived. Such a consensus is difficult to create and still much more difficult to maintain as "the time flows"

→ **Cycle (Inclusion); Exclusion Principle; Hippocampus; Morphic field; Nervous System; Object-in-time; Perception (Time limits in); Relativity postulate; Simultaneity**

2620

PRIMING¹⁾²⁾⁵⁾

The **process** of triggering an **effect** through an initial **input**.

This quite general **anticipatory process** can be found in physics (priming a pump) as well as in physiology and psychology.

An interesting case is semantic priming, in which a simple glance, or word can lead to the evocation of a much wider significance. An example could be "bomb", which bring **connotations** like "danger", "terrorism", "explosion", etc. (F. & P. LAVIGNE, 2000, p. 3-31)

→ **System (Anticipatory)**

2621

PRINCIPIA CYBERNETICA WEB ¹⁾

Johan BOLLEN (Vrije Universiteit Brussel) describes the Principia Cybernetica Project as a knowledge base for systems research. He writes:

"The Principia Cybernetica Project (PCP, founded in 1989, is devoted to the development of a complete and consistent cybernetic philosophy. The project's name refers to Russell and Whitehead's Principia Mathematica, the work that laid the philosophical foundations for the science of mathematics as we know it.

PCP, however, is not thought of as a closed, rigid set of axioms and definitions. Its basic architecture consists of nodes, representing concepts and their definitions, and links, representing the associations between the concepts. Nodes and links form a dynamic and continuously evolving network, incorporating the knowledge that makes up the Principia Cybernetica.

PCP was not designed as a specialized product of a few scientists, but rather as a collaborative development by many researchers in the field of systems science and cybernetics, each contributing their own viewpoint and expertise. Therefore, advanced collaboration and communication technologies are essential components.

PCP aims to build an adaptive and growing body of philosophical knowledge by applying cybernetic tools and methods to the development of cybernetics itself. PCP encourages multidisciplinary and tries to integrate the different viewpoints that make systems science and cybernetics such a diverse field. PCP investigates the process of collaborative knowledge. The research results will, in the spirit of the project, be fed back into the development of PCP through improvements to software and infrastructure. Our most recent research has focused on dynamically adjusting the structure of a knowledge network so that information will become more easily and efficiently accessible. The idea is to develop learning rules and algorithms that can ensure the network's soundness when the variety of the nodes and links increases. PCP aims to provide an information service to the cybernetics community. Accurate and up-to-date information on the main issues of the cybernetics and systems domain should be readily available to as many people as possible."

(IFSR Bulletin, p. 8-9, Dec. 1994)

PCP can be reached through : <http://pespmc1.vub.ac.be>

2622

PRIORITIES in systemic terms ^{1) - 4)}

In systemic terms, the most important priorities are the global and the **long term** ones. This unfortunately is quite contradictory to the generally **short term** vision and interests of individuals and **communities**, who consciously or not, are frequently disposed to sacrifice median or **long term** futures for quick benefits. G. HARDIN described a typical aspect of violation of global priorities in his "Tragedy of Commons"... without much real echo.

UNEP recommends to give highest priority to "urgent requirements to prevent further irreversible damage to living **resources**, e.g. extinction of species, loss of life support systems, etc..." (UNESCO-UNEP, p.22).

The re-orientation of global priorities is a matter of re-**education**, mainly at deciders **levels**, a very tall order indeed. It is to be feared that priorities will be modified only after the occurrence of considerable disasters, which would be nature's **feedback** to human abuse.

2623

PRIORITY of the SIMPLE ^{1) - 2)}

The necessary pre-existence of simpler **elements** prior to the shaping of more **complex systems**.

This general characteristic of a **hierarchy of complexity** in nature has been emphasized by H. SABELLI, who stated that the existence of simple systems or **organisms** does not depend on the existence of more complex ones, but conversely. Atoms are needed as building blocks for molecules; **cells** could not exist without molecules; nor generally societies without individuals.

However, once simple **components** become embedded in **complex systems**, they depend on the permanence or **survival** of these ones, a situation that SABELLI refers to as **supremacy of the complex**.

2624

PRIORS (Law of Universal) ³⁾

"The human being, **language** and reasoning through **relationships** are universal priors to science" (J. WARFIELD, 1995, p. 137).

WARFIELD contends that "there can be no science without all three of them" (1988, p. 339). The law, of course, unavoidably relativizes human **knowledge** from the **ontological** viewpoint. This is not dramatic, if its *obvious character is understood and taken in account*.

WARFIELD proposes a fourth universal prior relative to the "means to *represent* scientific **knowledge** in a manner that provides Referential Transparency"... as "the **representation** of

scientific **knowledge** forms the **linkage** between the investigator and the scientific **community**, and consequently **representation** is inherent in scientific pursuits".

Referential transparency is generally taken for granted. It implies however the *belief* in "interpretive **symmetry** between originator and receiver of **communications**, summarized in four essentials:

"a) That the linguistic terms needed to represent either exist in the **language** or will be created as required;

"b) that a way to organize the **description** exists or will be created;

"c) that the **design** of the **representation** will employ the foregoing, and

"d) that the **representation** can be assimilated and properly interpreted by both originator and receiver" (p.340).

Doubtlessly, the difficulties for systemists to make themselves understood into their **communities** have much to see with this fourth universal prior: Systemic **language** is still in process of ordering, and the **receivers** do not understand its meaning and possible uses. We should be heedful.

2625

PROACTION ¹⁾²⁾

"An **operation** through which the **output** of the system depends mainly on the capacity to forecast the effects of this **output** upon the **environment** and the system itself" (adapted from J.W. LAPIERRE, 1992, p.221)

This **concept** is very similar to the **feedforward model**.

2626

PROBABILISTIC VIEWPOINT ^{1) - 3)}

Science in general remained mostly **deterministic** till late in the 19th century, a **paradigm** perfectly expressed by the famous **Laplacian deterministic** statement.

The probabilistic view entered, for example through BOLTZMANN statistical **dynamics**, as a more or less opposed complement to **causal determinism**. It appeared as a kind of stochastic legality, merely juxtaposed to rigorous **determinism**, in the worst case.

The first inklings that these **dichotomic** views were too simplistic came through POINCARÉ'S **n-bodies problem**, which showed that even celestial mechanics could not be absolutely **deterministic**. The **trajectories** vagaries in POINCARÉ **phases space** were the first indications that **determinism** and **randomness** were more closely connected than hitherto believed.

The **chaotic behavior** recently discovered in many **phenomena** has emphasized the existence of movements which are globally **deterministic**, but anyhow unpredictable, or nearly so. This is also the case with **emergent dissi-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

pative structures, that depend on **random nucleation** at **bifurcation** points. As a result, it is now becoming widely admitted that **determinism** and **randomness** are inseparable aspects of **processes** and **systems** behavior.

2627

PROBABILITIES (STATISTIC) and STATISTICAL FREQUENCIES^{2) - 3)}

Statistics on probabilities are *relative to the past*: They reflect the numerous and varied results of a **random process** that already has taken place, and thus they are not any more probabilities. They are a rationalization of historical, unchangeable evidence, even if they provide us with at least a measure of **information** about the *nature* of the **process**.

P. VENDRYES clarify this point as follows: "When the same **random process** is repeated a great number of times, each time requires independence of the repetitions. The relative **frequencies** of the various possible outcomes tend towards the respective probabilities of each outcome. This tendency increases with the number of repetitions. These **frequencies** endow the probabilities with realistic values. They have been referred to as statistical probabilities. But these **frequencies** were actually manifest in the past, and *belong* to this past, whereas the probabilities are *virtual* and are turned toward the future" (1989, p.148).

Synthetically, **frequencies** are historical while probabilities are conjectural, i.e. based on some hidden postulates. The result, as stated by E. JANTSCH is that: "Most of the **models** applied so far assume **equilibrium** conditions and define probability accordingly", while "The recognition of **nonequilibrium** conditions ... leads to vastly different concepts" (1975, p.198).

2628

PROBABILITY¹⁾²⁾

The quality or condition of an **event** more or less likely to happen

This definition shows that probability implies necessarily a **criterion of evaluation**, i.e. depends on the **observer** in his/her specific mental, intellectual and even possibly affective or emotional state

However, once the conditions of **observation** have been clearly defined it becomes possible to introduce a more precise definition of what we mean by probability. As an example, the American Heritage Dictionary, under the sub-heading "Mathematics" defines probability as "a number expressing the likelihood of occurrence of a specific **event**, such as the ratio of the number of experimental results that would produce the event, to the total number of re-

sults considered possible" (p. 1043). Still, the use of the word "considered" shows the need for a criterion, normally obtained from a theory or some other **frame of reference**

2629

PROBABILITY (BAYESIAN)^{2) - 3)}

"The measure of the **plausibility** of an hypothesis or proposition".

Bayesian probabilities offer a measure of subjective **evaluations**.

Such probabilities "cannot readily be understood as **frequencies**, but they have a natural interpretation as indicating the speaker's degree of belief or confidence in the statement, given the available evidence" (W.H. JEFFERYS & J.O. BERGER, 1992, p.66).

Bayesian probabilities are used to quantify a belief or hypothesis related to some **situation** that cannot be experimentally repeated or produced, in which case no **frequencies** can be measured.

Of course "... subjective estimates (can) be modified as new **information** becomes available, leading to the revisions of a priori probabilities" (J.van GIGCH, 1978, p.202).

Generally, new information "more or less"-settles within the brackets of the former probabilities evaluation. "More or less" means that the effect of the new information will in most cases lead to narrower brackets of evaluation, i.e. diminishing the spread between upper and lesser values. An interesting practical example has been given by some marine biologists who re-evaluated the rockfish stocks in California (K. SHMIDT, 2003, p. 44-47)

→ **Fluctuation; Predictability; Randomness (Constrained); Randomness reduction**

2630

PROBLEM¹⁾

A ill-defined or **messy situation** or **issue**, which must be understood, decided-on and managed.

This is one of the most over-used word in our time.

But, to begin with, what does it mean? And, more specifically, what does it mean for systemists?

It seems to be generally accepted that a problem is a conflictive **situation** that should be somehow changed and "solved". We thus have "**problem solving**" and problem solvers. A leaky faucet can be a problem, but is obviously not in the same class as the world stock and distribution of nuclear bombs or the drying up of the Aral Sea.

For cyberneticians "a la WIENER" a faulty or inefficient **control** is a problem, while for a cybernetician "a la von FOERSTER" misunderstanding of so-called **facts by observers** is one, or for G. PASK it could be a confusing **conversation**.

For systemists "a la FORRESTER" it could be an incorrect **model** for **systems dynamics**, or for van GIGCH, a result of the neglect of the **metasystem** conditions, or for **networking** fans, an insufficient **understanding** of the **network** and of its possibly **chaotic behavior**.

We need not select our pet type of problem. We should understand that all the signaled types of problems – and many others – are frequently intertwined.

The very important general result of this situation is that we are always facing the following dangers:

- Forget that a problem has generally many facets. In the somewhat overdone definition by C.W. CHURCHMAN: "Something is a problem if and only if it is a member of the **set** of all other problems" (As quoted by I.I. MITROFF and H.A. LINSTONE, 1993, p.109).
- Try to apply partialized solutions to complex problems
- Remain inoperant because we cannot make up our mind in order to seek at least some solution, even if not **optimal**.

Solving a problem must not be restricted to purely **linear deterministic methods**. There may be good reasons to try to solve the problem in various ways. In many cases, **creative** insights may well deeply modify the terms of the problem and offer help to manage it.

Various recent systemic **methodologies** are tackling the "problem of understanding, managing or solving problems" as for example **Unbounded System Thinking** (I.I. MITROFF and H.A. LINSTONE), **Generic Design** (J. WARFIELD), **Design Conversation** (B. BANATHY and FUSCHL Group), **Total Systems Intervention** (M.C. JACKSON and R.L. FLOOD).

A curious aspect about problems is that, when they emerge to **consciousness**, they imply a newly structured vision... and in some individuals, the first insights about new **methods** for their solution. **Emergence** of systemics at the precise time of the appearance of numerous **situations** of high **complexity**, in which humanity has enmeshed itself, is surely not casual: it is a kind of individual and collective reaction, that may lead to "**distributed problem solving**".

2631

PROBLEM CONTEXT¹⁾

The **set** of conditions that produced the problem and may influence its present and future character.

M.C. JACKSON writes: "A problem can be defined to include the individual or **group** of individuals who are the would-be **problem solvers**, the system(s) within which the problem lie, and the **set** of relevant participants. This **set** contains all those who can make **decisions** that affect the **behavior** of the system(s)" (1992, p.27).

2632

PROBLEM DIAGNOSIS¹⁾

Any diagnosis reflects necessarily the specific viewpoint and aims of the **observer**. However some general guidelines are useful in all cases.

The most difficult stage is probably the first one, i.e. symptoms detection, for the following reasons:

- We see that what we are looking for, what we are prepared to perceive in accordance with our past experience, while we tend to remain blind and deaf to anything else;
- We have a very imperfect **perception of time scales**, i.e. of the **differences between short, medium and long term processes**;
- We mostly lack the capacity to perceive complex **interrelations** and frequently miss to perceive even the most obvious and critical ones (see FRANÇOIS's study of Man-made disasters – 1989b).

All this adds up to De ZEEUW's **invisibility** and FOURASTIÉ's ignorance of ignorance.

Once the symptoms partly or totally observed, we must understand their **meaning**, trying to sort out the subjective part of our interpretations. This search for **meaning** should also be creative by forming hypotheses about the possible **interrelations** between symptoms and by searching for other clues in apparently unrelated areas, without of course overextension (in itself a subjective **criterion**) of this **inquiry**.

Finally, it may be useful to construct a formal **model** of our **diagnosis**. This is however also a risky endeavor, since formal **modelization** is subject to **rules** whose use may or may not distort the observed **situation**.

2633

PROBLEM FORMULATION²⁾

The statement as precise as possible of the unsatisfactory **situation** or **issue**, in relation to the possibilities to correct it.

Apart from the difficulties of the **diagnosis**, problem formulation depends on the viewpoint of different **stakeholders**. The unilateral view of only one or some of them, when imposed through the use of authority, frequently leads to new problems.

Given these caveats, we can follow K. KRIPPENDORFF's description: The problem can be identified by specifying:

- "a) the undesirable and problematic **state** currently occupied,
- "b) the **resources** currently available to move away from that problematic **state**, particularly the available courses of **actions**, the combinatorial **constraints** on using them, etc, and
- "c) the **criteria** that need to be satisfied to say that a problem no longer exists or is solved" (1986, p.61).

J. WARFIELD's **Interpretive Structural Modeling** seems to be the most efficient **methodology** for problem formulation.

2634

PROBLEM (How do we define a)²⁾

In his paper "**Perception** of the future and the future of **perception**", H.von FOERSTER thus quotes H. BRUN: "The definition of a problem and the **action** taken to solve it depend on the view which the individuals or **groups** that discovered the problem have of the system to which it refers. A problem may thus find itself defined as a badly interpreted **output**, or as a faulty **output** of a faulty **output** device, or as a faulty **output** due to a malfunction in an otherwise faultless system, or as a correct but undesired **output** from a faultless and thus undesirable system. All definitions but the last suggest corrective **action**, only the last definition suggest **change**, and so presents an unsolvable problem to anyone opposed to **change**" (1971, p 1-10).

The basic point is that "correction" does not imply "**change**", while "**change**" is sometimes absolutely necessary to insure that "corrections" should not merely be superficial, deceptive and, in last resort, useless patching.

Even so, a good **knowledge** of the system is needed if the thus considered "**change**" is not to play havoc with the whole system. Many **changes** are always possible, but each proposed one should be in accordance with the global **organization** of the system.

And finally, one should never forget that any **change** may merely *displace* the problem. As observed once by B. BANATHY: "You cannot solve a problem, you only can manage it".

J. WARFIELD proposes to clarify the definition of any problem by covering the following points:

- "1. A well-conceived title for the problem or **issue**.
- "2. A descriptive **scenario**, explaining the nature of the problem, and how it came to be a problem, presenting as much history and **data** as can be prepared with available **resources**.
- "3. An **understanding** of what disciplines or professions are relevant to an attack on the problem.
- "4. An **assessment** of scope.
- "5. A determination of the societal sectors involved.
- "6. An identification of the actors to be involved in the problem-solving **situation**.
- "7. An identification of need.
- "8. An identification of alterables (those **elements** of the system that are subject to **change**)
- "9. An identification of major **constraints**.
- "10. Some partitioning of the problem into relevant **elements**.
- "11. Some isolation of the subjective **elements** of the problem

"12. Description of **interactions** among relevant **elements** of the problem" (1989, p.150).

2635

PROBLEM (Ill-structured)^{2) - 4)}

A problem "which cannot be expressed in precise terms" (P. CHECKLAND, 1976, p.131).

Problems implying ecological and/or human factors are by necessity ill-structured because they can normally not be reduced to precise quantification. Or quantification would be simply an artificial way to eliminate psychological or sociological non quantifiable **values**.

CHECKLAND, who established the concept, states: "Their crucial characteristic is taken to be that they are *unstructured*, and the aim has been to find a way of using systems ideas to tackle them without having first to define them sharply, without forcing them into a structured form. This is deemed necessary because if a problem is stated in a well-defined form its solution is usually implicit in the definition, and such "solutions", in real-world problems, tend to pass the problem by. In the **management** science area, for example, we all learn to recognize the **queuing theory** enthusiast who readily sees problems as queueing problems, thus enabling him comfortably to use his favorite technique" (p.132).

CHECKLAND proposes "... a more open analysis of *the situation within which a problem is perceived*" and, of course who perceives it".

When the **situation** is clearly perceived by the various actors "... debate ensues which aims to define **changes** which meet two **criteria**: are they arguably *desirable*?; are they, in the **situation** we have, *feasible*? If *desirable* and *feasible* **changes** emerge then **action** in the original problem **situation** is possible. If **changes** meeting those two **criteria** do not emerge, then we may explore more radical or more conservative viewpoints via further conceptual **models** – and in so doing *learn*. The **methodology** is in fact a **learning** system (in contrast to those **methodologies** for "hard" **systems engineering** which deal in terms of "**design**" and "**optimization**" and "implementation") (Ibid).

In this way, CHECKLAND's **methodology** deals with the relative **invisibility** of the environmental **situation** of the problem, a very dangerous feature when **decision-making** is needed about supposed "*desirable*" and/or "*feasible*" **change**.

Let us note however that the **concept** of **design** has evolved notably since CHECKLAND wrote these lines.(1976)

→ **Problem (Well structured)**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

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PROBLEM SET²⁾³⁾⁴⁾

The word "problem", after being used and abused widely all along time, has finally lost any clear meaning for most people. J. WARFIELD writes: "Extensive empirical evidence in working with **complexity** has made clear that the statement "let's begin by defining the problem" is the opening scene of an evolving linguistic nightmare". Whenever complexity is involved nearly all **stakeholders** in some **situation of issue** have different views about what the "problem" is. This is the recipe for confuse, or even incoherent debate, for muddled thinking and inefficient meandering **management** through "**underconceptualization**" as defined by J. WARFIELD.

In effect, the apparently clear **concept** of "the problem" totally obscures the fact that most problematic **situations** have multiple concurrent (and even **synergetic**) **causes**.

It tends to lead astray the would be "problem solvers" making them believe that, "finding "the" cause of the problem", it will be easy to "solve".

Warfield proposes to consider what he calls a "problem set", which would include as many as possible of the converging causes of different kinds, at different **levels**.

He also observes that any problem definition is a human construct, and as such, of course, depending on probably different and even divergent views of the **stakeholders**.

Unless a wide-open **conversation** is instigated with an appropriate technique, the so-called "problem" would probably be misunderstood and conflicting unresolved views would lead to **underconceptualization**, leading in turn to costly mistaken **decisions**.

→ **Clanthink; Design (Generic); Group technique (Nominal); Groupthink; Solution**

2637

PROBLEM (Soft)¹⁾⁴⁾

Generally a real world problem that cannot merely be tackled in terms of seeking convenient means to reach a simple determined **goal**.

In soft problems - characteristic of the real world **issues** - the **stakeholders** are in most cases numerous and of different classes. As such they frequently have different outlooks and **goals**, rooted in different worldviews and intentions. This makes the problem very difficult to understand for anyone (J. WARFIELD's "**Underconceptualization**"), to modelize and to manage. This led P. CHECKLAND (1981) to his Soft System **Methodology** and, more recently R. RODRIGUEZ ULLOA (1994) to his **Soft Systems Dynamics Methodology**, which combines FORRESTER's **Systems Dynamics**

(1961, 1969, 1971) with CHECKLAND's approach, adding moreover a cultural angle, very significant in intercultural interventions and in culturally **heterogeneous human groups**.

2638

PROBLEM SOLVER¹⁾

Someone who is supposedly able to offer a solution to a problem.

von FOERSTER writes: "... there are no problem solvers, because they do not have any problem in the first place. It is *our* problem they help us to solve, like any other useful tool, say, a hammer which may be dubbed a problem solver for driving nails into a board. The danger in this subtle **semantic** twist by which the responsibility for **action** is shifted from man to a **machine** lies in making us lose sight of the problem of **cognition**" (1981, p.237).

Such a caveat is surely justified: as we all know, when some mistake had taken place, the (ir)responsible factotum was always inclined to tell us: "The computer made a mistake". Of course, nobody believes that anymore nowadays.

Farther afield, no **machine** can give a correct answer if fed with an incorrect **model** of the question or **situation**. ("Garbage in, garbage out").

As to her/his practical **efficiency**, the problem solver depends on the tools mastered: "... the challenge is to find **algorithms** that give reasonably good solutions reasonably quickly" (R. MATTHEWS, 1995, p.42). Recently, the arsenal of the problem solver has become enriched with new tools, as for example **genetic algorithms** and **connectionist models**.

2639

PROBLEM SOLVING^{1) - 2) - 4)}

"An **activity** aimed at closing the cognitive gap en route to a **goal** by employing acts of **processes** neither immediately nor obviously suitable towards this end" (K. KRIPPENDORFF, 1986, p.61).

Problem solving has been discussed by H. SIMON, in relation to specific tasks as for example "discovering the proof of a difficult theorem". He states: "The process can be - and often has been - described as a search through a maze. Starting with the axioms and previously proved theorems, various **transformations** allowed by the **rules** of the mathematical systems are attempted, to obtain new expressions. These are modified in turn until, with persistence and good fortune, a sequence or **path of transformations** is discovered that leads to the **goal**" (1965, p.67). He adds: "The **process** usually involves a great deal of **trial and error**... which is not completely **random** and blind". (We are up to a point, guided by the **rules**). As a result, **trial and error** search is "selective" (Ibid).

Problem solving is however generally referring to very much more difficult issues.

This seductive - but sometimes deceptive - concept effectively conceals quite different **situations**. The resolution by computer of a mathematical problem or geometric theorem; the inquiry about some specialized problem by an **expert system**; or the difficult **process of decision-making** by a businessman or a statesman are widely different matters.

The first type corresponds to a very simple sequence from the abstract **model** to the solution, still in the abstract world of the **model**.

Once we deal with a **concrete system**, three other - and quite critical - steps must be taken. The first is the construction of the **model**, in which the **percepts**, concepts and intentions of the **model builder(s)** are heavily conditioning factors. The second one is the interpretation of the abstract solution obtained from the **model** (through some supposedly correct **methodology**) in relation to the **concrete system's** nature and conditions (which supposedly kindly remained **invariant** in the mean time), and the third one is the implementation of the solution in the **concrete system** (which implies many human and practical **resources** and **means**, hopefully at disposal).

It is thus not surprising that about real world **situations** B. BANATHY says: "You cannot really solve a problem, you can only manage it". In the same vein, as stated by P.M. ALLEN: "Clearly, what constitutes a "problem" and what is considered a "solution" depend on the particular views of the moment, and any **action** taken with the intention of providing a solution to a problem will in fact push the system along one evolutionary **path** rather than another. Since such **decisions** are usually taken without any real **knowledge** of what the system would have done anyway, and what new problems lie along its changed **path**, then it is not surprising that the general feeling as to the overall effect of such interventions is somewhat less than euphoric" (1982, p.60). No wonder G. VICKERS spoke of "the poverty of problem solving"

→ **(Planning (Anticipatory) and Planning (Interactive))**

To these reflexions, D. Mc NEIL adds the following: The "Problem-solving **paradigm**" "pretends to **objectivity** and the particular rationality of a **linear** world which is reducible to "things out there". It presumes that a technological arsenal of "problem-solving tools" could mechanize and eventually offer mastery of **prediction** and **control**. Ultimately, the "problem-solving" **paradigm** provides at best only a patchwork of partial, local and temporary "solutions" to "problems" which are themselves the results of "solutions to problems" ad infinitum" (1993a, p.3).

Problem-solving also presents a significant cybernetic angle, as stated by P.S. HENSHAW: "Knowledge of the outcome of the last previous act is a key to problem-solving, **decision-making and behavior**" (1975, p.23).

It is even more complex than this, because the **situation** may very well have changed due to new and yet unregistered **environmental** factors which may render our **solution** – now out of step – inoperant or even downright harmful.

G.S. SAMARAS indicted (in 1974, but it is still true nowadays): "... the prevalence of erroneous problem-solving – the 'cybernetic sacrilege' of viewing **complex systems** with superficial oversimplification. A fundamental element of any problem-solving, **decision-making process** is determining whether the observed **phenomenon** is an "isolated" **state** of superficial cause or a manifestation of some subtle, underlying source. Many current **decisions** treat our complex problems as **states** instead of symptoms. The implementation of these ineffective solutions is abetted by the lack of involvement of the scientific **community** and the ignorance of the general public" (1974, p.1).

KRIPPENDORFF emits a more or less similar caveat: "The contemporary emphasis on finding technological solutions to human problems is the principal motor for the **growth** of technology, but also the principal source of ecological **disequilibria** and of many human problems and social **instabilities**" (p.86).

This "problem with problem solving", particularly in **human systems**, is now more clearly perceived and various new systemic **concepts** and **methodologies** have emerged during the last twenty years:

- St. BEER **Viable System Model**
- R.L. FLOOD and M.C. JACKSON's **Total Systems Intervention**
- The FUSCHL Group's **Design Conversations**.
- J.A. JOHANNESSEN and A. HAUAN's **holographic and heterarchical model of the organization**
- I.I. MITROFF and H.A. LINSTONE's **Unbounded Systems Thinking**
- J. WARFIELD's **Generic Design** and associated **methodologies**

P. CHECKLAND's "**Soft Systems methodology**" and C.W. CHURCHMAN's views about the "**Design of Inquiring Systems**" have inspired most of these developments.

2640

PROBLEM (Well structured)²⁾

According to A. NEWELL: "A problem is well structured to the extent that it satisfies the following **criteria**:

- "1. It can be described in terms of numerical **variables**, scalar and vector quantities.

"2. The **goals** attained can be specified in terms of a well defined **objective function** – for example, the **maximization** of profit or the **minimization** of **cost**.

"3. There exist computational **routines (algorithms)** that permit the solution to be found and stated in actual numerical terms" (as quoted by J.van GIGCH, 1978, p.379).

This stand is obviously referring to quite simple business, or economic, or technical problems where abstraction can be made of human (and possibly qualitative ecological) factors.

van GIGCH observes "... ill-structured problems are amenable only to solutions by **heuristics**".

→ Problem (ill structured)

2641

PROBLEMATIQUE¹⁾

"A **graphical pattern** showing how members of a set of **problems** identified in a given **situation** aggravate or do not aggravate one another" (J. WARFIELD, 1995a, p.160).

The **pattern** represents the interconnected **set** of all **interactions** between the **elements** of a complex **problem**, as discovered through **Interpretive Structural Modeling** used by a **group** as representative as possible of all **stakeholders**.

As stated by J. WARFIELD and R. CARDENAS: "... it is the primary basis for **understanding** how the **effects** of work done to diminish **problems** propagate into the total **program**. If, for example, someone diminishes a certain **problem**, but does nothing to diminish those other **problems** that have been aggravating it, it is very likely that the **problem** that was diminished will make a strong comeback, and nothing useful will have been accomplished; while time will have been lost" (1994, p.307).

The **problematique** is thus useful in order to discover and if needed, eliminate undesirable **side effects**.

J. WARFIELD comments: "One of the significant values in such a **pattern** is that it reveals, to those who have produced it, the small **sub-set** of **problems** that are highly influential in preserving the problematic nature of the **situation**; while also revealing which **problems** tend to be created by other **problems**. In addition, it often reveals the presence of "problem cycles"; i.e. **subsets** of **problems** that are mutually aggravating, tending to form a small **problem** world unto themselves, and giving a clue to the actors that such **cycles** may have to be dealt collectively with a **strategy** that recognizes the reinforcing **feedback** at work".

WARFIELD gives a graphical example, from which "it is very apparent that the **problematique** is not **linear**" (p.161).

A different, but more limited and less significant meaning is given to **problematique** in France, as "A world **representation** which questions the observed results" (M. LIU, 1989, p.41).

Here, the **problematique** affects "the **observer**", i.e. not a **group**, but merely an individual.

According to M. LIU: "A **problematique** is, for the **observer**, linked to some **situation** from which it arises...

"The **problematique**, as defined by a researcher, is linked to his own **situation**...

"A **problematique** is deduced from a **situation** by way of a **diagnosis**." (Ibid.)

Obviously, a **diagnosis** will be more valuable if resulting from the **consensus** in a **group** of **stakeholders**.

Warfield advocates the replacement of the expression "complex problem" by "problematique" in order "to show how the different **component** problems of what might be otherwise called a "complex problem" are interrelated, leaving aside the human tendency to want to think in terms of a one-**element set** (e.g. "the problem", free of interacting members)"

In his view this would eliminate simplistic and illusory **solutions** which generally lead to the re-emergence of the "problem".

J.N. WARFIELD and C.H. PERINO Jr. in a more recent paper explain that **problematique** as a concept and methodology "benefited from the writings of ARISTOTLE, ABELARD, LEIBNIZ, DE MORGAN, C.S. PEIRCE and HARARY". They add that the idea "has been extended to represent a structural portrayal applicable to specific problematic **situations**" and "Having been tested in many such situations, it can now be viewed as a standard format of wide utility in many applications"(1999, p. 221)

→ **Interpretive structural modeling; Interactive management; Problem solving; Soft system methodology; Total system intervention**

2642

PROBLEMATIQUE OF TECNOCENTRIC SOCIETIES⁴⁾

"The contemporary **problematique** is the result of a still prevailing **value** system based on expansion, **competition**, domination and exploitation"(unstated source)

It would seem that every historical expansive **socio-cultural system** rested on this typical **behavior**.

Moreover, the success of most former empires seem to have been due to adequate **sub-systems** of **communications**, **exchange**, and administrative **organization** in coincidence with a certain superior state of technical development or in accordance with some specific characteristics of the **environment** (Island, plains, deserts, etc.)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Older examples have been the military use of horses, the invention of gunpowder, the introduction of good instruments for oceanic navigation, of the steam engine and the internal combustion engine.

In a sense all of the successful human **groups**, states or empires have been made possible by some technical superiority.

However, in our contemporaries societies, technical **progress**- especially thought the use of highly concentrated energy led to the absolute **dominance** of technical **subsystems** within the general **organization**. In the older societies, even the quite limited power of techniques always ended in some crisis, be it for their insufficiencies, be it for more or less widespread abuse against the human or natural environment.

Technique tends to act as a magnifying lens and empowering device on anything it is applied to.

As our modern societies are hypertechnified, a better **evaluation** of the impact of technique on all human systems and subsystems seems to be in urgent need to enter our **systems research** agenda.

→ **Club of Rome; Commons; Criticality; FEEDBACK (POSITIVE); TECHNOSPHERE; THRESHOLD OF STIMULATION**

2643

PROBLEMS (TYPOLOGY of)¹⁾

Typification of problems is a thorny issue.

However, at least one basic **criterion** should be applied: Problems are **linear** or **nonlinear**.

Linear problems respond to simple **models**, but must be of the ... *et ceteris paribus* type, i.e. they must be immune to any **changes** of their nature, or environment, a quite improbable **situation**.

Complex systems present mostly **nonlinear** problems, resulting of a **variety** of **behavior modes** as, for instance: be submitted to **regulations**; respond **simultaneously** to different **cyclical activities**; obey to **chaotic determinism**; be close to an **instability limit** due to **dissipative structuration**; be **organizationally closed**, etc...

Using **linear models** to solve **nonlinear** problems leads normally to pseudo-solutions. It is possibly still more dangerous to be unaware of **linear** assumptions that one may bring unwittingly along when searching for solutions.

The most insidious of all is the belief that **nonlinear** problems can have perfect and complete solutions.

2644

PROCEDURE¹⁾²⁾

A set of established **methods** or sequence of **actions** prescribed to manage specific kinds of systems or **issues**.

Procedures generally include some more or less automatic **behaviors** or **routines**.

2645

PROCESS^{1) - 2)}

1) "Any **change** over **time** of **matter**, **energy** or **information**" (J.G. MILLER, 1978, p.23).

2) "A sequence of **behavior** corresponding to a **goal-producing function** in a system" (Adapted from R.L. ACKOFF, 1972).

M. CERÉJIDO writes: "Systems do not undergo processes; they are the **forms** that manifest the processes" (1978, p.32). Obviously, as observed by E. JANTSCH (1976), suppression of processes with the illusory **goal** to stabilize **structures**, would lead to the total (and impossible) blocking and invariability of the system, while fugacity of **structures** would produce a total lack of **coherence** in processes. In none of these cases could a system survive.

A process presents three basic aspects:

- A **function** of transference in **time**, through **storage** or **memory**;
- **Functions** of **transfer** in **space**, i. e. displacements or **transmission**;
- **Functions** corresponding to morphologic changes: variations in **form**, or of **information** content. (After J.C. LUGAN, 1993, p.95).

Of course, any process is **energy** driven and any transference is in **space and time**.

MILLER writes: "If the equation describing a process is the same, no matter the temporal **variable**, it is a **reversible** process; otherwise it is **irreversible**, or better less readily reversible" (Ibid).

He adds: "Process includes the ongoing **function** of a system, reversible **actions** succeeding each other from moment to moment... Process also includes **history**, less readily reversed **changes** like mutations, birth, **growth**, **development**, **aging** and death; **changes** which commonly follow trauma or disease; and **changes** resulting from **learning** which are not later forgotten" (Ibid).

All these "less **reversible**" **changes** are practically totally **irreversible**. Further comments of MILLER show that the word "reversible" must be understood as "which can be replaced or reconstructed" and not in its abstract mathematical **meaning** "**time invariant**" (see the critique of the concept of **reversibility**).

As to ACKOFF, he comments: "The sequence of **behavior** that is performed by the electronic rat constitutes a maze-solving process... The **metabolic** process in living things is a similar type of sequence the **goal** of which is acquisition of **energy** or, more generally, **survival**... Process **behavior** displayed by the system may be either reactive, responsive, or active" (Ibid).

2646

PROCESS (Anticipatory)²⁾

A process proper to a system able to construct a working **model** of its **environment** and use it for **decision making** and **forecasting purposes**.

Because of the **survival value** of such abilities, it is probable that they impelled the differentiation and complexification of the **nervous system** all along the **evolutive process**.

Anticipatory processes are now widely recognized in biology and in **cognitive sciences**.

The subject is also closely related to **computation** and to **neural networks**.

It has become the focal point of the **CHAOS Society** (Centre for Hyperincursion and Anticipation in Ordered System) based at the Institute of Mathematics, University of Liège, Belgium.

2647

PROCESS (Dissipative)^{1) - 5)}

The process of dissipation of **energy** in a system.

I. PRIGOGINE emphasizes that: "Dissipative processes that destroy **structure** at and **near equilibrium**, may **create** these **structures** when sufficiently **far- from- equilibrium**" (1984, p.47).

In such cases, the system is trying to cope with an **overload** of **energy** through the search for a new **dynamic equilibrium** at a higher **level of complexity**.

2648

PROCESS (Generative)

→ **Process Theory**

2649

PROCESS CONTROL²⁾

The permanent **adjustment** of the **process** in order to maintain it in correct working order.

In cybernetic terms, this is obtained through **feedbacks**.

In **learning** in a **neural network**, **control** is implicit in the **parallel distributed processing software**.

2650

PROCESS INTERACTIONS during autogenesis²⁾

According to BERTALANFFY "... the **primary regulations** in organic systems (i.e. the most important **regulations** in embryonic **development** and in **evolution**) were rooted precisely in **dynamic interaction**" (1940, p.57).

This implies that complex and, to begin with, non-hierarchical interactions precede **regulations**. This seems possible during the **auto-genesis** phase of any class of systems, when the **whole** can still be reestablished from a **part**, as for example in the famous experience by DRIESCH with divided embryos of urchins.

→ **Autogenetic systems precursor (CSANYI, 1993, p.263).**

2651

PROCESS METHOD ^{1) - 2)}

H. SABELLI derives a "process method" from his **process theory**: "Postulating that everything is a process, **process theory** leads one to study **time series** as **models** for nature. **Process theory** postulates that all processes include simple **components** the form of which can be described as numerical orders: (0) the **disorder** of **randomness**; (1) oneness of temporal **asymmetry**; (2) twoness of opposition or **symmetry**; (3) tridimensionality of **space**. These simpler forms combine to generate spiral **components (FIBONACCI series 0,1,2,3,5,8...)** and to create complex multidimensional **components**... We apply this idea to the study of mathematical **time series**, and **time series of data** obtained from complex biological processes, using the **time delay** method to construct dimensional frameworks..." (1994, p.1488).

2652

PROCESS MODEL ¹⁾²⁾³⁾⁴⁾

"An organized arrangement of systems **concepts** and principles that portray the **behavior** of a system through **time**" (K. BAUSCH, Glossary, pers. comm., 2002)

BAUSCH adds: "Its **metaphor** is the "motion - picture" or "movie" of the system" (Ibid)

In fact, the choice of the "concepts" and "principles" is of enormous importance.

There are many kinds of processes, as for example different types of **growth** processes; **continous discontinous** processes (cyclical processes of various types, **self - organized criticality**, **equilibria** of different types, **synergetic** processes)

The **modelling** of any process implies either an **interpretation** of experimental results, or the selection of a specific model, in an hypothetical way to begin with. Generally both **modes** of reworking of the **data** must be simultaneously used.

The difficulties are still more severe when modelling human economic, or social processes, due to the psychological and cultural aspects of model selection.

→ **Model accuracy; Model building; Modeling (Systemic); Models (Functions and uses of); Modelization; Modelization Methodology; Process theory**

2653

PROCESS (Self Amplifying) ^{1) - 2)}

A process submitted to a positive feedback.

Such processes are driven away from equilibrium and can lead:

- either to explosive destruction
- or to **emergence** toward a higher organizational level.

However, in **autocatalytic** processes, there is no more than a self-amplification limited in time.

2654

PROCESS (Self-destructive) ^{1) - 2)}

A process affected by a repetitive **feedback** which tends to finally annulate it.

The **feedback** may be **positive** or **negative**. A **positive feedback** leads to the exhaustion of some **input** or **environmental** condition basic for the **maintenance** of the process or the **survival** of the system in which it is functional. Examples are the exhaustion of oxygen for a fire in a closed **environment**; the growing **costs** of scientific research, the progressive clogging of traffic by a growing number of vehicles and the acceleration of technological obsolescence.

The **negative feedback** reduces either the **inputs** or the width of the **fluctuation** band of the process, and progressively stifles it. Examples are starvation or reduced **resilience** in **ageing living systems**, or declining **adaptability** in an **organization**.

The only way to avoid self-destructiveness in processes is a convenient blend of **negative** and **positive** feedbacks.

2655

PROCESS (Social Distributing) ⁴⁾

The way a wide **variety** of tasks are allocated or re-allocated in a **social system**.

Distributing processes have been researched experimentally in ants nests by D.M. GORDON through a **variety** of perturbing experiments affecting the **environment**, or the **population structure** of the ants. (1995, p.50-57)

The general conclusion is that the distributing process is the global result of **networking** through multiple **communication** among the ants.

GORDON also observed that global **order** is more stable in mature colonies than in new ones. Her conclusions are quite probably also valid in **human systems**, where more or less spontaneous **reorganization** can frequently be observed when they are violently and suddenly disturbed, as for example in war or massive terrorist attacks, or great natural disasters.

2656

PROCESS THEORY ^{1) - 2) - 3) - 4) - 5)}

A **General System theory** organized around the **dynamics of processes**.

Process theory (P.T.) has been introduced by H. SABELLI (1989). He states: "P.T. adopts as its basic postulate PASTEUR's **concept** of cosmic **asymmetry**, i.e. the existence of **asymmetry** in all and each entity, in all and each of its qualities, an **asymmetry** that provides processes with **energy** and **order**... Systems are asymmetric **organizations** of **energy**, **information** and **matter** created by the **interaction** of opposite forces... Every system has an inside-outside **asymmetry**, a past-future **asymmetry**, and an **energetic asymmetry**" (L. CARLSON-SABELLI & H. SABELLI, 1992, p.681).

Moreover, "P.T. postulates the **bifurcation** of opposites, not their synthesis, or their annihilation" and "P.T. proposes that **chance** and **cause** have **priority**, while **choice** and **creativity** have **supremacy**" (H. SABELLI & L. CARLSON-SABELLI, 1994).

And: "According to P.T., **levels of organization** are **topologically embedded forms**, ordered **hierarchically** from simple to complex" (Ibid) In **human systems** "P.T. offers a framework within which to study social processes: the law of biological **priority** and psychological **supremacy**" (Ibid).

On the other hand, "According to P.T., the co-existence of three or more oppositions creates partial **equilibria**, i.e. **structures**" Moreover: "Processes create **structures** and **structures** create processes" (Ibid).

SABELLI proposes three basic laws of P.T.:

"1. Energetic asymmetry: All is **action** (where **action** = **energy** x **time**) Thus everything spontaneously changes and exchanges. Everything is a process, i.e. a composite of **actions**, and hence have two **asymmetries**, the potential of **energy** and the unidirectionality of **time**. Because all processes are forms of the same **energy**, they change in the same direction, **time**. **Action** is universal **asymmetry** of nature.

"2. Entropy as symmetry: universality of opposition: Every process and every **structure** includes two opposite **components** (**enantiodromia**): attraction and repulsion, union and separation, **asymmetry** and **symmetry**, left and right, positive and negative. For instance, every physical force of attraction has a **range** at which it repels. Gravity itself is counterbalanced by the spontaneous expansion of the universe. Every **change** generates its opposite, so processes increase their internal **symmetry**, tending toward **attractors** and forming **structures**. **Symmetric equilibrium** is always partial and local. Isolated from **interactions**, processes flow toward stable **attractors** - a fundamental **asymmetry** of nature - but an **attractor** is a balance of **symmetry** between opposites.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"3. Co-creative **organization**: the generation of **complexity**: Natural processes spontaneously create material **structures**, i.e. **asymmetric patterns of energy and information** in tridimensional **space**. The formation of **matter** from **energy** in the **evolution of universe**, the spontaneous formation of condensation **structures**, the formation of **dissipative structures** in **chaotic attractors**, the spontaneous synthesis of inorganic molecules, the generation of living **organisms**, the evolutionary increase in the number, **diversity and complexity** of species, the **development** of varied social cultures, and the psychological processes of individuation – all illustrate the spontaneous creation and destruction of **structures** through a multiplicity of different processes" (1994, p.1485-7).

The SABELLIs also propose a way to introduce mathematical **methodology** in P.T.: "It is convenient to express P.T. in more abstract terms: all natural and social processes are high dimensional transient complexes created by the **interaction** of pre-existing and universal low-dimensional **patterns** (cosmic forms). Being universal, these cosmic forms have numerical, geometric, algebraic, physical, biological and psychosocial **representations**: (0) zero order, **random** statistical **distribution**, quantum flux, genetic chance, luck; (1) oneness, unidirectionality, **symmetry**, **asymmetric** ordering relation (**lattice** theory), temporal flow of **time**, **energy**, life and history, social and psychological **asymmetries** and **hierarchies**; (2) twoness, opposition, **group** inverse, particles and anti-particles, two-valued **information**, sexes, complementary social **roles**, love-pairing; (3) triadicity, trifurcations, tridimensional **matter**, **structures**, tripartite **organization** of color **perception**, and of social mental **models**, and periodicities of order three that generate **chaos** (YORKE and LI). These simple processes interact with each other to create higher dimensional processes and thereby novelty, diversity, **complexity** and individuality (diversification). The numeral description of these forms may correspond to the **FIBONACCI series** (0,1,2,3,5,8, etc.) found in biological processes and in aesthetic **choices**... In summary, P.T. postulates a **hierarchical embedding** of changeable multidimensional **structures (topology)** (as contrasted to **attractors** which are conceived as mutually exclusive **patterns**) hence processes have a **self-similar fractal geometry**" (Ibid).

Process theory has obvious philosophic pre-socratic undertones (HERACLITUS, PYTHAGORAS and EMPEDOCLES), as well as Hegelian ones. Even if some P.T. concepts could seem controversial, it is however also solidly founded on a wide experimental basis in biology applied to medicine, psychology and psychiatry (in SABELLI's more specialized work).

SABELLI himself has assessed P.T. as a **general systems theory**: "Process theory was born as a bridge between biological and psychosocial medicine, highlights its continuity from HERACLITUS to PRIGOGINE, and makes the confrontation of multiple hypothesis, rather than the single-minded pursuit of one... P.T. differs from other G.S.T in three basic issues: (a) The existence of **boundaries** selecting the kind and **rate of inputs and outputs** has been considered a fundamental aspect of the definition of system. P.T. conceives also of **boundary-less** systems such as the solar system. Each entity has a **set** of entities interacting with it; thus each person is the center of her or his social **network**; obviously such **networks** overlap, have no **boundaries**, and include entities which do not directly interact with each other. (b) Organic **models** of systems highlight the **integration** of opposing **parts** in a totality, whereas P.T. gives equal importance to harmonic **integration** and **conflictual competition** and struggle. For instance, instead of viewing family and institutions as **subsystems** of society, P.T. views nation, places of work, families as mutually **synergic** and mutually competitive and conflictual systems which include each person. Even biological **organisms** are not simply **homeostatic** systems maintained by harmonic **interactions** among their component **parts**, but include processes that necessarily lead to death. (c) The **hierarchy** of systems has been defined in terms of **size** (subatomic, atomic, molecular, **organismic**, planetary, solar, etc.), using the **analogy** of Russian dolls or Chinese boxes. This scheme splits the physical **level of organization** and places social processes above psychological ones. P.T. postulates that **interactions** between **levels of organization** are organized by their historical **priority** and their **informational complexity** (mathematical, physical, chemical, biochemical, biological, social, psychological, spiritual); hence **social systems** are considered to have historical **priority** over psychological **organisms**, while personal processes are recognized as more complex than social processes... (But) the **biosphere**, the **population**, the **social system**, have **priority** over the individuals they contain. Systemic causes have **priority** over individual processes. The **complexity** of the system is *less* than the **complexity** of anyone of its individual **parts**; likewise a mechanical system is simpler than its atomic **structure**. In summary, P.T. views **structures** and systems as transient **developments** within processes, rather than viewing processes and **structures** as complementary aspects of systems" (1991).

P.T. is completed in psychosocial science by a Process method, based on what SABELLI calls "**action graphs**", i.e. paper and pencil diagrams of interpersonal exchanges of **energy**

(labor), **information** (about self and others, affection, entertainment, practical, social and intellectual skills) and **matter** (money and property).

2657

PROCESS THERMODYNAMICS²⁾ – 5)

H. SABELLI reconsiders thermodynamics from the viewpoint of process theory: "According to **process theory**:

(1) Everything is **action**, the **asymmetric flow of energy in time**. (2) Every action is associated with an opposing process, thus generating **symmetry**; the **maximization of entropy** represents this tendency toward the generation of **symmetry**. (3) Processes create **structures** (partial **symmetries**) at critical and intermediate values of temperature and dimensionality. Postulating that **asymmetry** and **symmetry** are cosmic forms that order all natural processes and **structures**, **process theory** provides a reformulation of **entropy** as **symmetry** rather than **disorder**, and of its **maximization** as a cosmic **asymmetry**. The tendency of processes to attain a more stable **configuration** creates **symmetry** in natural systems. The various forms of partial **symmetry** attained include not only more uniform and probable **distribution** of the system **components**, but also the formation of complex and **asymmetric structures**. **Entropy** thus increases everywhere, and faster in a **complex system** than in its simpler **environment** (1994, p.1484).

In other words, **order** and **disorder** are opposed, but complementary, a concept formulated by SABELLI under the term "**enantiodromia**".

As to **maximization of entropy**, considered as reflecting growing **symmetry**, it is supposed to mean that total statistical **disorder** (in a gas for instance), should be equated with maximum **symmetry**, i.e. the inexistence of significant **asymmetric** features.

In accordance with PRIGOGINE's **thermodynamics**, it would be advisable to speak of increase of **entropy production** in **complex systems**, and not merely of **entropy**.

2658

PROCESSES (A taxonomy of)¹⁾ – 2)

This is no more than a tentative taxonomy based on different descriptions of processes made independently by various authors.

- **Causal process**: "A process such as, if the **state** of system is exactly known in a given moment, it becomes possible to univocally determine its **state** in a future instant".

This definition by V. TONINI (1971, p.227), related to Laplacian view of determinism, is obviously theoretical. While all processes are necessarily causal, their **perfect knowledge** at any moment is impossible.

- **Chaotic process:** A process proper to any **complex system** with **sensibility** to its **initial conditions**.

A chaotic process remains basically **deterministic**, but its development is not precisely predictable, as it turns generally probabilistic, within fuzzily determined **channels**.

- **Cybernetic process:** "A process submitted to **regulations** aiming at the elimination of unfavorable probabilities and optimize the favorable ones" (TONINI, p.229).

This is the classical **control** process of N. WIENER.

- **Cyclical process:** A process in which interconnected, but different regularities lead to **periodic oscillations**.

This type of processes is a typical result of any **endogenously** or **exogenously** generated **constraint**. There are various types of cyclical processes, as:

- cyclical with progressively **damped oscillations**, resulting from the dominance of the **negative feedback** over the positive one. It may lead to the destruction of the system by blockage.

- cyclical with progressive **amplified oscillations**, a result of the dominance of the **positive feedback** which can lead to the destruction of the system or to **dissipative structuration** and the possible **emergence** of a more **complex system**.

- **Ergodic process:** A succession of **states** of a system which depends directly from its most recent **state**, but also in a stochastic way from a **transitions** probability **matrix** which reflects the more or less lax general **constraints** on the system.

- **linear process:** A **monotonous** process in which a same quantitative cause produces a same corresponding quantitative effect.

- **logistic process:** A process in which a first **period** of **nonlinear growth** is succeeded by an also **nonlinear** decelerating **period**.

A logistic process can lead either to an asymptotic **limit**, or to a more or less strong **relaxation oscillation**.

- **nonlinear process:** A process in which an accumulative cause (geometric, exponential, hyperbolic or logarithmic), or a **feedback** leads to non-monotonous increasing or decreasing **effects**.

If not **regulated**, nonlinear processes lead to deep **changes** in systems and, sometimes to their destruction or **mutation**.

- **Stochastic process:** "A process that produces a series of **symbols** in accordance with certain probabilities" (C. SHANNON, 1949).

Replacing "**symbols**" by "**effects**" this **communication theory** definition can be considerably extended.

Stochastic processes allow for global **forecasts**, but not about any specific determined **behavior**.

- **Undetermined process:** "A process for which no perfect **knowledge** of the original **state** of the system is possible" (TONINI, p.228).

2659

PROCESSING (Parallel distributed)²⁾

The simultaneous processing of numerous different **data** in different **parts** of a **network**.

Such seems to be basically the way the **brain** does process the sensorial **inputs**. While a digital computer works at a pace measured in billionths of seconds, neurons work at the pace of merely thousands of seconds. But in about a tenth of a second, the **brain** recognizes anyone of a fabulous number of features of many kinds. This is a result of teamwork among groups of neurons *sharing* parts of the task. This is the basis of **connectionism**, whose concepts are now applied with increasing success to build the so-called **connection machines**.

2660

PROCESSING: Simultaneous or sequential²⁾

In common computation, processing is sequential. It: "requires that both **data** and instructions be encoded into notation" (F. FRISCHKNECHT and J.P.van GIGCH, 1989, p.245).

Symbol manipulation of this kind does not allow for **autonomous behavior** of the **artefact**. Moreover, it tends to be **dichotomic**, opposing **state** and **process**, as observed by the cited authors.

For example: "In A. I. we have a **state language** and a **process language**. In psychology **knowledge** is contrasted with **learning**, **memory** with **cognition** and imprinting with constructing. And systems have **states** and an **evolution process**" (p.246).

The authors explain many other implications of the **dichotomic** character of our processing **artefacts**.

Comparing the computer and the **brain**, as **data** processing devices, J.von NEUMANN wrote: "... the natural componentry favors **automata** with more, but slower **organs**, while the artificial ones favors the reverse arrangement of fewer, but faster, **organs**. Hence it is to be expected that an efficiently organized large natural **automaton** (like the human nervous system) will tend to pick up as many logical (or informational) items as possible **simultaneously**, while an efficiently organized large artificial **automaton** (like a large modern computing machine) will be more likely to do things successively..." (1958, p.50-51).

von NEUMANN expressed this at his Silliman lectures in 1956. The basic idea is still valid, in spite of the fabulous progress in computer's hardware. However, it seems now quite possi-

ble that the future **connection machines** will mimic more and more efficiently our "large natural **automaton**"... with results which are anybody's guess.

Finally, the universal problem seems to be: how to obtain complex and **integrated** thinking out of the basically **binary** processing, both in the computer and in the **brain**.

M. BODEN understands that there are basically two types of thinking; the "sequential-deliberative" and the "**parallel-intuitive**" (1990, p.205). The first one would be monotonically **time-ordered** in **linear** sequences, while the second one would be moreover multi-**simultaneous**.

BODEN adds: "By means of **parallel** processing of various kinds, human minds are well suited to have **serendipitous** ideas" (p.220).

2661

PROCESSOR²⁾

A device that operates a specific **transformation** within a system or an exchange between the system and its **environment**.

This notion, introduced by J.L.LE MOIGNE, corresponds approximately to the concept of **critical subsystem** of J.G. MILLER and somewhat less so to J. FORRESTER's **gates** (1973).

LE MOIGNE states: "The elemental processor can be identified in a general way by various characteristics whose definition shall frequently guide the **model** builder: In "*extensity*", it can be recognized by its **capacity** (of **storage**, transportation, production) or its **power**; in "*intensity*" by its **output**, or its **level**, or its **efficacy**, or its **yield** (a numerical relation between the **output** and the **input** at a given moment), or by its **efficiency** (a relation, possibly even qualitative, between its observed **behavior** and the hoped for **behavior**)" (1977, p.79).

LE MOIGNE observes that: "A priori an elemental processor may well process various kinds of **flows**: various **inputs** and various **outputs**. It may also be affected by different **fields**, which may influence the **stability** in time of its **behaviors**" (Ibid).

2662

PROCESSORS (Set of the)²⁾

According to J.L.LE MOIGNE, the **set** of the processors of a system composes a **net**, whose **connections** can be figured by a **graph** or represented by a square matrix (1977, p.87).

The processors' **net** makes up the **structure** of the system and its graphical and matricial **representations** permits its structural analysis.

LE MOIGNE sorts out the internal processors of the system as opposed to those which connect it with its **environment**. These last are of two different kinds: the **sources**, which in the **model** have no **inputs** and the **sinks**, which have no **outputs**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

LE MOIGNE's "**Système général**" is a "net marked off in an **environment**".

2663

PRODUCER^{1) - 2)}

"The **subsystem** which forms stable **associations** that endure for significant **periods** among **matter-energy inputs** in the system or **outputs** from its **converter**" (J.G. MILLER, 1978, p.3).

This is one of the 20 **critical subsystems** in MILLER's **taxonomy of living systems**.

MILLER adds: "... the materials being synthesized being for **growth**, damage repair, or replacement of **components** of the system, or for providing **energy** for moving or constituting the system's **outputs** of products or **information markers** to its **suprasystem**" (Ibid).

Clearly, "producer" is a generic term covering many types of specific or specialized producers.

2664

PRODUCT INHIBITION^{1) - 4)}

The **situation** in which one or various products of the system's **processes** finally impedes these **processes**.

The **model** for this situation is the inhibition of a chemical reaction by the very products of the reaction.

This seems however to be only an example of a very general systemic **phenomenon**: the inhibition takes place because the product saturates either the **environment** or the **invironment** of the system by suppressing some indispensable condition for the **process**.

Product inhibition implies a strong warning for **human systems**.

2665

PRODUCTION^{1) - 2)}

Any process of **transformation** within a system or **subsystem** that leads to the creation of new **elements**, usable for other **subsystems** or systems.

The production **processes** are clearly described by J.G. MILLER in his "**Living Systems**" (1978).

Production should be regulated as closely as possible to the needs of the users **subsystems** or systems in order to avoid squandering of **resources**, or either **overload** or **underload** of the producing and the receiving systems.

2666

PRODUCTIVITY as a systemic concept¹⁾

As noted by R.O. MASON, the common concept of productivity is, from a systemic viewpoint quite questionable. It may refer to some material **outputs** of the system, or to some services

the system offers to other systems, or in some cases to its own overall **efficiency** or even its **survival capacity**.

According to MASON: "Systemic productivity questions the **design** of the system itself: Is it living up to its maximum feasible potential? Is it doing what it ought to do to develop its **resources** and to pursue opportunities? In a disturbed, reactive **environment** these are the salient questions" (1979, p.17).

MASON moreover distinguishes between:

"**Systemic output productivity** (as) the ratio: Actual **output** divided by the maximal **output** that could be produced by the best alternative, feasible, designable and importable system of the same class", and...

"**Systemic input productivity** (as) the ratio: Minimal **input resources** that are required to produce a given **level of output** by the best alternative, feasible, designable and importable system of the same functional class divided by the actual **input resource** consumed to produce that **level of output**" (p.27).

MASON concludes: "Systemic productivity is an indicator of the long-run **survival** and **viability** of the system" (p.28).

The systemic **concept** of productivity is thus very close to **thermodynamic efficiency** of the productive system and should not be reduced to the idea of maximum possible productivity.

2667

PROGRAM^{1) - 2)}

1. "A **set of code signs** that indicate the **actions** to be performed by a **living system** or an **artefact** in order to achieve its **purpose**" (J.Z. YOUNG, 1974, p.297).

J.Z. YOUNG adds: "In **living systems**, the aim is the continuation of the individual and/or his programs" (Ibid).

Programs are ordered in the **time** dimension: their execution is sequential. Moreover, at least **parts** of the program are recurrent, which leads to **autopoiesis** and **hypercycles**.

The future development of a complex program is somehow **implicit**: **complex systems** are **self-organizing**. This is true only – at least until now – for **living systems**. It seems however that **self-organization** starting from a **set** of rules is now becoming a feature of some **artifacts**. See: "**Connection machine**".

In **living systems** the **combinatorics** implicit in the program is unavoidably limited, even if it may be very great. This may be setting **limits** to **learning** and even to the lifespan in **living systems**.

2668

PROGRAM (COMPUTER)⁵⁾

"A list of statements or instructions in a special purpose programming **language** that directs a computer to undertake a certain computer task" (K. KRIPPENDORFF, 1986, p.61).

In fact, such a program is a more or less complex **algorithm**.

T.ÖREN writes: "A computer program is a **knowledge transducer** similar to any **energy transducer**. A computer program has an **input knowledge** and an **output knowledge**. A **knowledge transducer**, i.e. a computer program, can do three types of **knowledge** processing:

- 1) It can **transform** its **input knowledge** into **output knowledge**.
- 2) It can provide **knowledge** about an **input knowledge**, and
- 3) based on an **input** (a query for example), it can process some **knowledge** that exist in a **knowledge base**, to provide an **output knowledge**" (1990, p.13).

For the use of the word "**knowledge**" instead of "**information**" see B. ZEIGLER comments under "**Knowledge**: a pragmatic and operative views".

2669

PROGRAM (Developmental)²⁾

A type of constructive **set of rules** that leads to development by variable **interactions** between the rules and in relation to variable external conditions

It is becoming clearer with time that no **complex adaptable system** can be rigidly programmed, i.e. that it cannot be constructed using an **algorithm** – even a very complex one.

This corresponds to the very need for **adaptability** to continually changing conditions. It could be the basic significance of the construction of complex entities (biological, social) "**by trial and error**" and in accordance with the **bottom up model**.

It is now widely admitted that the classical so called "**artificial intelligence**" based on complex programming (for ex. chess programs for computers) lacks the basic adaptability of **human intelligence**.

→ **Artificial Life; Homeobox; Parallel distributed processing**

2670

PROGRAM (Inductive)^{2) - 5)}

A program using "a purely logical approach to find abstractly defined regularities in the **data**, irrespective of subject-matter" (M. BODEN, 1990, p.186).

M. BODEN states: "A **learning** program that uses this logical strategy can structure a "**classification-by-property**" **conceptual space** in the most economical way, and can find the shortest pathway for locating examples within it... The program defines not only the relevant search-tree but also the most efficient tree-search. It learns to ask the right questions in the right order, so as to decide as quickly as possible".

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

This type of programs is now used in **expert systems**.

2671

PROGRAMMED CONTROL

→ **Control (Programmed)**

2672

PROGRAMMED INSTRUCTION¹⁾ – 5)

"A technique for presenting a subject matter to a student who can work through it at his own **learning speed**" (K. KRIPPENDORFF, 1986, p.59).

KRIPPENDORFF describes it as "... a **network** of statements and tests, which direct the student to new statements depending on his **pattern of errors**" (Ibid).

The technique is useful, specially when applied to precise formal errorless **data** systems. But it supposes that the programmer rigorously channels the student's **training** (no sidelines!, no critique other than the one implicitly included into the program!). And it supposes that the student is sheepishly disposed to navigate the programmed **channels**. Finally, it implies a SKINNERIAN **behavioristic** concept of **training** by conditioning.

2673

PROGRAMMED LEARNING¹⁾

A more embracing and open training **method** to teach appropriate **knowledge** to individuals, "aimed at the right **level**, sequential and logical and entirely compatible with the **objectives** and intentions of the individual and the **organization**" (After I.G. BLOOR, 1987, p.43).

BLOOR states that some years ago "self-paced material was developed to enhance **flexibility** and **choice** in the form of specially written texts that included self-**assessment**. Today's equivalent of this training technique is known as Open Learning which offer the **flexibility** of self-paced study with the additional support from an internal or external (e.g. a college) trainer" (Ibid).

From a systemic viewpoint, the crux of the matter is the *quality of the content* of the offered texts, which should be oriented to an integrated vision of what is to be learned, in order to broaden the **understanding** of the user.

2674

PROGRAMMING⁵⁾

A **procedure** aimed at solving some type of problems on base of existing **data** and fixed **rules** to process them, and ordering the presentation of results.

This is mostly done by using computers, with adequate programming **languages**.

It should however never be forgotten that programming is a tool at the service of **management** and **planning**, which means:

- that it should correctly reflect the **goals** pursued by the overseers
- that, once the first condition satisfied, it cannot be held responsible for conceptual **errors** of managers or planners.

2675

PROGRAMMING (Dominant)²⁾

The **top-down** construction of a program in **artificial intelligence** research.

C. EMMECHE explains: "The total **behavior** is programmed a priori by dividing it into strictly defined subsequences of **behavior**, which are in turn divided in **subroutines**, smaller **subroutines**, etc., all the way down to the **program's own machine code**". (1994, p.19)

It could be argued that the **top-down method** has engaged classical **artificial intelligence** into a dead-end, because it precludes any possibility of non-programmed **adaptability**, **creativity** or **emergent behavior**.

EMMECHE implicitly makes the point, adding: "The **bottom-up method** in **artificial life** imitates or simulates **processes** in nature that organize themselves" (Ibid).

This means that **artificial life** cannot be simulated or created by dominant programming.

2676

PROGRESS¹⁾ – 3) – 4)

The advance towards a positively valued **goal**.

This is a heavily **value**-loaden *concept* which should be considered carefully from a systemic viewpoint.

To begin with, progress should not be confused with progression or increase of quantitative values. Such an increase is normal in immature systems developing along **chreods** until they reach their normal **homeostatic** grown-up **level**. It would turn pathological once such **homeostatic state** has been attained. This, at least, is the case for **living systems**, but altogether probably for social ones.

However, quantitative increase may conceivably lead to qualitative progress, if one admits that **structuration** by **dissipation** in systems **far- from- equilibrium** can lead to a higher **complexity level**.

This view may explain why our materially exploding culture equates so generally progress with quantitative increase (that seems in fact to increase **complexity**). However, there are some **processes**, as for example exponential supposedly limitless **growth**, or non-compensated **positive feedback** that may easily lead to the demise of the system by exhaustion of its **environmental sources** or massive **overburdening** of its **environmental sinks**.

Thus, progress should not necessarily be identified with **growth** or increase. We should also make ourselves aware of our cultural prejudices as members of a techno-economical based culture, which could very well be preparing for itself some serious **problems** generated by its own success.

2677

PROPAGATION¹⁾

The spread or dissimulation of some characteristic in a **population**, or between **elements** or **subsystems** in a system.

Propagation is possible only if the characteristic is **adaptive**, or at least not counter-adaptive. It is quite generally limited because no **environment** can support the unlimited **growth** of any type of system. Excessive propagation of some **population** normally leads to a crash.

This may also be the case for techniques, ideas (**memes**) and the like, a subject that would be useful to research.

From another viewpoint, propagation is never instantaneous and quite unfrequently **isotropic** and/or **isochronic**. As the basic interaction mechanism, it can be **linear** or **nonlinear**, in this case with different types of **feedbacks**, on different **rhythms** in **time**. It can also take place in **hierarchical levels**, between **components**, or **clusters of components**, organized or not in **subsystems**.

The **simultaneous** propagation of various **effects** within a system can lead to more or less **deterministic chaos**.

See for example J.C. ECCLES about propagation of impulses within the cerebral cortex (1977, p.201-2).

Propagation **modes** are also of great importance in **human systems**.

→ **Criticality; Percolation**

2678

PROPAGULE¹⁾⁽²⁾⁽⁵⁾

A reproductive **element** able to migrate far away from its original **population** or system.

L. PITELKA et al. use the term in botanical **ecology** (1997, p.467).

Seeds carried away by strong winds, or transported by vertebrates are classical examples.

Propagules frequently play an important role in dispersal and expansion of **epidemics** through new and widely scattered foci. A recent example is intercontinental AIDS **propagation**.

Another example is the explosive expansion of forest or bush fires by sparks or burning twigs carried away by fire storms in conflagrations.

Propagules are probably a condition, or at least a very significant factor in **percolation phenomena**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Accordingly and in an extended **meaning**, reproductive **elements** of any kind as for example bacteria, books, fashions, slogans, **memes**, etc. can be considered propagules.

2679

PROPERTIES (Systemic)^{1) - 2)}

The French systemist B. WALLISER proposed the following properties as characteristic of systems:

Diacronic properties: "Set of the **relations** among the various characteristics of the system at successive moments" (1977, p.73).

Synchronic properties: "Set of the **relations** among the various characteristics of the system at the same moment" (p.73).

In a system both **synchronic** and **diachronic** properties must be permanently non-contradictory.

Emergent property: "Any new property of the system that is not a property of any of its **sub-systems** or **elements** and is essentially due to the characteristics of the **net** of their **interrelations**" (p.47).

Immergent property: "Property of some **subsystem** that cannot anymore be found at the **level** of the system" (p.47).

Both types of properties can be synthesized as follows: "A system is at the same time, more and less than the sum of its **parts**".

2680

PROPERTY and FUNCTION¹⁾

F. BONSACK emphasizes the necessity to clearly distinguish "property" from "function". He writes on the topic:

"Some biochemist say: "To fix oxygen is a **property** of hemoglobin. To say that it is its **function** does not add anything, if not a finalist connotation, that should be eliminated from modern science..."

"It is true that, *when we isolate* hemoglobin, it has only properties. A property characterizes an isolated substance, it is tied to this substance. To speak of "function" has no sense here. The function is no property of the chemical substance, it is a property of the functional **organization** of the **whole**. The **property** of hemoglobin to fix or to liberate oxygen is used by the function "transport of oxygen from the lungs to the tissues".

"The function is not tied to the chemical substance (just as it is not tied to a person who occupies some post in an **organization**). The proof of this is that *another* substance (or another person) may act in the same function. Conversely, the same substance (or person) may perform different functions in the same **organism** (or **organization**) or in a different **organism**" (1989, p.23-4).

2681

PROPERTY (Emergent)→ **Emergent properties**

2682

PROSPECTIVE^{1) - 4)}

The French name for scientific **forecasting**.

Prospective has been introduced in France by G. BERGER (1964) and considerably developed by the "FUTURIBLES" group under the leadership of B.de JOUVENEL. Its conceptual foundations have been researched by Ch. FRA-NÇOIS (1976).

Its spirit is quite different from American futurology, albeit closer to English futurics as reflected in the journal "FUTURES". It is more concerned by the **validity limits** of any proposed **forecasts**.

It has also a higher level of insight in relation to **complexity** in **nonlinear systems**, avoids linear **extrapolations** and remains generally wary about *any extrapolation*. It is thus more concerned by **systemics** than futurology is. This stand has been considerably reinforced in the recent years with the development of **deterministic chaos**, which infuses a salutary skepticism about so many pseudo scientific "**scenarios**".

Prospectivists are also generally aware of the traps of the voluntarist illusions of some managers who lack clear ideas about the **interactions** of the system they govern with its complex **environment** and remain prone to ill-advised, **short term** and superficial tinkering.

2683

PROTOCOL²⁾

A register of the successive **states** of a **variable**.

ASHBY introduced this notion in relation to the **black box model**. He wrote that the protocol could "... be regarded as a **message** that contains **information** about the box's nature" and added that "... the investigator's **knowledge** about the box, in any of its aspects, must be essentially a recoding of what is in the protocol: he may not claim more.

"From this point of view, to discover something about the **black box** – something that has permanence – is to discover a **constraint** in the protocol" (1958, p.201).

2684

PROTOCOL (Compacting a)²⁾

According to ASHBY: "The study of a system can thus be summed up in a few words: to discover the **constraints**, the statistical **structure**, in the protocol" (1958, p.201).

This is possible only if the protocol does not show absolute **randomness**, but on the contrary contains a certain amount of **redundancy**.

In this case, "... a recoding of the **redundancies** (or **constraints**)" (Ibid) permits a degree of "compacting" of the protocol and the discovery of some more or less permanent "**property**" of the system. This **procedure** permits the elaboration of simpler **messages** that contain all the **information** included in the protocol, but without **redundancy**.

2685

PROTOFUNCTION²⁾

The **structure-shaping** effect of some new **components** whose **interactions** may lead to the **self-organization** of a system.

This concept has been introduced by V. CSANYI (1989, p.78) and is related to his **replicative selection** and **zero- system model**. CSANYI states: "The protofunctions are formed at **random** in the **zero-system**. Certain conditions for the **emergence** of the **cyclic organization** of these protofunctions and the existence of completely reproducing chemical **networks** (RCN), have been found by KING (1982, p.85-87)".

2686

PROXEMICS¹⁾⁴⁾

"Man's use of **space** as an aspect of his **culture**" (E.H. HALL, 1977, p. 248)

This notion includes "conversational distance, **planning** and use of interior **spaces**, town layout and the like"(Ibid)

HALL's concept is rooted in what he calls the "intrusion **distance**" which is related to the physical and psychological **reaction** of an individual who feels discomfort, anger or anxiety when his/her "personal space" is invaded.

This is somehow the opposite of critical proximity (see hereafter). It seems however that, in human beings also, critical proximity may produce a sudden change of **behavior**, transforming them upon a critical **threshold** from individuals into **elements** in a **crowd**.

According to HALL, members of distinct **cultures** have slightly different ways to perceive critical proximity.

An intriguing point is the possibility that the strong social compression that results from the planetary **population explosion** during the 20th C. could lead either to unbearable psychological **stress** among people or contrarily to the general acceptance and tolerance of a reduced intrusion space.

The historical consequences for the whole of mankind could, in both cases, be impressive.

N. ORT gives another interesting definition of proxemics: "The **semiotic** aspect of territory in non-verbal **communication**" (2001, p.153). This clearly implies that proxemics has its roots in animal behavior.

2687

PROXIMITY (Critical) ²⁾

The distance **limit** over which **components** cannot anymore interact.

Critical proximity is generally determined by converging **exogenous** forces. **Interactions** can however also start when masses of loose **elements** start to converge (in a proto-star f. ex.) or when their **density** increases over a **critical threshold** (in locust **swarms**, in **Dicystostelium discoideum**).

In such cases, a self-maintaining **process**, corresponding to **organizational closure**, is initiated, which will last for the whole **life-time** of the system or society.

→ **Positional value; Proxemics**

2688

PSYCHOLOGY (Ecological) ³⁾

This is a concept coined by the American psychologist J.J. GIBSON (1986).

Ecological psychology recognizes the **co-evolution** of animals and their **environments**, and pursues a principle of animal-environment reciprocity as its basic guideline.

This has been a reaction against two opposite extremes: pure mentalism that divorces the animal's **behavior** from **environmental constraints** and **behaviorism**, which trivialize its reactions to the **environment** at a too simple **habituation** and conditioning level.

→ **Perception (Ecological)**

2689

PSYCHOLOGY (Genetic) ³⁾

As observed by E. ANDREEWSKY, PIAGET's genetic psychology's basic concepts are closely related to systemic ones. She writes: "A child builds his own intelligence by means of his **interactions** with both his inner biological **environment** (maturation of the nervous system) and his outer physical **environment** (his actions on **objects**) as well as his social **environment** (**language**, **cooperation** with adults and other children). The **interactions** between these **interactions**, which PIAGET calls *equilibration*, is the means of organizing this **set of interactions** into a system" (1993, p.187).

ANDREEWSKY also relates VIGOTSKY's Social Interactionism with PIAGET's social accommodation (p.188).

2690

PSYCHOLOGY (Systemic) ^{3) - 5)}

von FOERSTER's **Cybernetics of 2nd order** and, later on MATURANA and VARELA's concepts of **autopoiesis** and **organizational closure** have deeply modified the stand and viewpoints of a number of psychologists.

Some of them now admit that they should be careful, lest they instill their own views into the psychological or psychopathological **situation** they have to consider, with a serious risk to distort it.

In effect, psychology's endeavor is "the **evaluation** of human systems by evaluatory human systems" (R. GLANVILLE, 1979, p.37)

Indeed, "The actions of an (experimenting) **observer** are **actions** involving **control** and **communication** between the **observing** and the observed system" (ibid, p.37). We thus should speak of "a reflective and reflexive psychology" (ibid)

A powerful movement of "systemic psychology" has surfaced in Argentina, possibly too exclusively related to the **autopoietic model**, not considering enough other systemic and cybernetic **concepts** and **models** that could be of interest in psychology.

2691

PSYCHON ^{3) - 5)}

"Any neural unit capable of discharging mental **functions** of some kind" (M. BUNGE, 1979, p.128).

BUNGE, who introduced this neologism, states that "there are three main views concerning the nature and size of psychons: neuronism (sic), **holism** and systemism. According to neuronism single neurons may possess certain mental abilities – e.g. that of issuing **commands**. There is no evidence for this view. Holists, on the other hand, assume that nothing short of the whole **brain** can mind: they speak of "mass action" and favor **holographic** theories of **memory** and other mental **functions**. Although there is plenty of evidence for the strong coupling among a number of **neural** systems, there is also evidence for **localization** of, e.g., pleasure and speech.

"So we are left with *psychosystemism*, or the hypothesis that the **brain**... is a system of specialized **subsystems** or **organs**, some of which are itinerant rather than fixed. There is multiple evidence for psychosystemism, so we shall adopt it" (p.128-9).

BUNGE's neologism has not spread much and the negative aspects of his views may still not be generally accepted.

2692

PSYCHOSOMATIC NETWORK ⁵⁾

The globally integrated network that interconnects the **nervous system** with the endocrine system and the immune system

The existence of this global network has been established by C. PERT and results of the general action of about 60 to 70 different peptides which act as messengers and mediators between the more specifically acting systems

In the words of F. CAPRA, who offers a synthesis of PERT's research the "conceptual separations are merely historical **artifacts** that can no longer be maintained" (1997, p. 282)

2693

PURPOSE ^{3) - 5)}

"The aim or **objective** of a **living system** (or artefact) as indicated by the standards embodied in its **program of controls**, including those standards acquired by **learning**" (J.Z. YOUNG, 1974, p.297)

This definition by-passes the willfulness problem, at least in the case of most **living systems**, since most of them have no possibility of **control** over their own **program**.

However, in their 1943 foundational paper about "**Behavior, purpose and teleology**", A. ROSENBLUETH, N. WIENER and J. BIGELOW wrote: "The basis of the concept of purpose is the awareness of "voluntary **activity**"... The term purposeful is meant to denote that the **act** or **behavior** may be interpreted as directed to the attainment of a **goal**, i.e., to a final condition in which the behaving **object** reaches a definite **correlation** in **time** or in **space** with respect to another **object** or **event**. Purposeless **behavior** then is that which is not interpreted as directed to a **goal**".

And: "... the purpose of voluntary **acts** is not a matter of arbitrary interpretation but a physiological fact. When we perform a voluntary **action** what we select voluntarily is a specific purpose, not a specific movement" (1943, p.19).

These authors also state: "All purposeful **behavior** may be considered to require **negative feedback**. If a **goal** is to be attained, some **signals** from the **goal** are necessary at some **time** to direct the **behavior**".

These quotations call for some remarks;

1. Are **living systems**, or **artefacts** "**goals**" to be distinguished, and if so, how? The **goal** of a **cybernetic artefact** is introduced by its builder. However, once there, it becomes an **autonomous** feature of the **artefact**.

2. Is the presence of a **negative feedback** always a **signal** of the existence of a "**goal**", or "purpose"?

3. **Goals** are, by necessity, the **present representation** of a **state** to be attained or maintained. There is thus no paradox about a supposed influence of the future upon the present.

G. PASK distinguishes "purposes for systems", as the **function** we assign to them within some larger **context** and "purposes in systems" as the internal **goals** driving their **behavior**. He adds that "... we cannot make sense of a system without assuming a purpose for or in it thus all systems are **purposeful**" (1969 – as quoted by W.R. WINBURN, 1991, p.555)

Or course, such assumptions are "ours".

As to the purpose of **artifacts**, until now at least, it is strictly defined by their constructors. An intriguing question would be to define the possible purposes of **artifacts** which would "acquire standards by **learning**".

J.van GIGCH offers a **context** view of purpose: Inanimate systems are devoid of visible purpose. "They acquire a specific *purpose* or *function* when they enter into **relationship** with other **subsystems** in the **context** of a larger system" (1978, p.14). Purpose has thus a reactive character.

According to W.T. POWERS, "In a **control-system model**, a purpose is simply a **reference signal**. The reference signal determines the state to which an **input**, a sensory **signal**, will be brought and at which it will be maintained. In nearly all control systems, the sensory input represents the state of some external variable affected by the system's **action**. So whatever action brings the sensory signal to match with the reference signal performs brings the sensed external **variable** to some specific **reference state**" (from POWERS' internet page, 1999). This implies some internal **feedback** embedded within the control **level**.

Thus, what is meant by purpose in every specific case, is defined by the system's level of **organization**.

Consequently, the very diverse uses of the term may easily lead to **semantic** muddles and conceptual confusion.

On the other hand T.W. DEACON, in a 2001 review of G. CZIKO's book "The things we do" (2000), mentions that "According to POWERS, purpose is concretely represented as a perceptual **reference signal** in some internal **feedback loop** embedded in other higher order **feedback loops**"

→ **Finality; Teleonomy**

2694

PURPOSE in SOCIAL SYSTEMS ⁴⁾

The idea of purpose in social systems is a conceptual quagmire. At least three different viewpoints can be distinguished:

- 1) The one, more or less naive, of many leaders who believe that *they themselves* define the purposes of the system. What they really do is to try to instill *their own* purposes into it, i.e.:
 - what they believe the system could or should do; In this case they merely act accordingly to what they *think* they know about the system's nature;
 - what they want the system to do: In this case they act generally according to some **values** and **norms** that they received... from some part of the system itself, and they frequently do so quite unwittingly.

- 2) What the system *apparently* does: its members perceive merely what they were educated to see by **learning** or ideologic indoctrination: In this way, they are of course in for many surprises.

- 3) What the system *really* does, i.e. trying to survive, which implies many unexpected **behaviors**, whose **understanding** generally dawns upon the participants quite a long time after the **events** themselves.

D. KATZ and R.L. KAHN think that: "*It would be much better theoretically*, however, to start with concepts which do not call for identifying the purposes of the **designers** and then correcting for them when they do not seem to be fulfilled. The theoretical **concepts** should begin with the **input**, **output**, and functioning of the **organization** as a system and not with the rational purposes of its leaders" (1966, p.89).

Numerous systemic concepts and **models** could be used to study **social systems**, in accordance with J.G. MILLER's **methodology** and could lead to a new type of systemic sociology.

2695

PURPOSEFUL, Intentional, or willed ⁴⁾

"An **activity** which is purposeful becomes an **action**" (R. RODRIGUEZ ULLOA, Glossary, 1999)

2696

PURPOSIVE ^{3/4)}

"Describable by an **observer** as serving a purpose" (R. RODRIGUEZ ULLOA, Glossary, 1999)

If purposiveness depends on an **observer's** view, it becomes clear that different **observers** may have different - and even contradictory - views of the supposed **purpose** of the **action** they are observing.

This may be significant in any **model building process** and even generate **conflicts**.

2697

PYRAMID ^{2) - 4)}

A **hierarchy** wherein many subordinate **levels** are submitted to one **control level**.

W.D. GROSSMANN and K.E.F. WATT observe that, while "SIMON provided examples demonstrating why a **hierarchical** architecture increases the probability of reliable functioning... the **noise** to **signal** ratios increase in **messages** communicated between **hierarchical levels** as the number of **levels** increases (S. BEER, 1976). This means that it becomes increasingly difficult for the head of an **organization** to integrate and co-ordinate the **activities** of all **levels** and subdivisions within each **level**, as the number of **levels** increases" (1992, p.9).

The enormous problems suffered by some well known giant multinational enterprises is a neat proof of this.

Q

2698

QUALIA ^{1/5)}

The inner states of **perception** that we describes as qualities

Examples are the "blueness" of blue, or the "saltiness" of salt. The ways these inner states appear (and in specific cases become refined, as for ex. in the perception of shades of green by a painter) is still quite unexplained. It is however the bedrock of our inner **representation** of **reality** and the source of the **communication** ability between humans who are supposed to have equal or equivalent inner perception of "saltiness" or "blueness" or any other psychological **percept**

This subject has been extensively explored by G. EDELMAN and J. SEARLE, for example

2699

QUALITATIVE LAWS ^{1) - 2) - 3)}

Qualitative laws are generalizations of similar, but non-measurable properties. This is the basic mental **process** that leads to fundamentally new discoveries.

M. BODEN cites as an example: "The chemist GLAUBER (who) clarified the qualitative **distinction** between acids and alcalis, and between acids and bases (Bases include both alcalis and metals). He did so by classifying the experimental observations - including some produced in experiments he designed himself - in a logically coherent way. He discovered, for instance, that every acid reacts with every alcali to form a salt" (1990, p. 197-8).

H. SIMON and colleagues have designed a **program** named GLAUBER that modelizes the discovery of qualitative laws "by classifying things according to their observable properties" (Ibid).

Qualitative laws are frequently the first step to quantitative ones. A good example is MENDEL's quantification of inheritance laws, that were already more or less known in qualitative terms by plants and animals empirical breeders.

In a more formal domain, R. THOM observed that **topology** is basically a qualitative branch of **mathematics**. Qualitative mathematical **structures** are interesting, even if not measurable (1991, p.79).

2700

QUALITY CONTROL in Interactive Management ⁴⁾

This is not quality control of material products. As understood by J. WARFIELD, it concerns attitudes related to **management** and **planning**, as well as to **ethics** in general systemic terms. WARFIELD specifies five key concerns in this sense:

" Concern for the client
 " Concern for I.M. practitioners
 " Concern for I.M. participants
 " Concern for the reputation of I.M.
 " Concern for the society as a **whole**" (pers. comm.)

Only this generally concerned attitude can avoid local or global negative **side effects**, of which we observe a growing number of increasing gravity. Consequently, WARFIELD considers that "Unless all five concerns can be dealt with favorably in the particular **situation**, **activity** should be terminated" (Ibid).

A very difficult problem remains: How to diffuse these views in societies that do not care?

2701

QUANTITATIVE into QUALITATIVE ²⁽³⁾

(from statistics to quasi-systems - or **composite systems**; from **composite systems** to **markovian systems**, etc...)

New qualitative **behavior** seems to emerge from massive quantitative and interactive **behavior** of many **elements**. This old view of MARX and ENGELS is now reframed within the **criticality** and **percolation models**.

2702

QUANTUM HOLOGRAM (Non local)

→ Hologram (Non- local quantum)

2703

QUANTUM VACUUM ³⁽⁵⁾

"The **energy** substrate from which the material **universe** is taken to have emerged"(G. FARRE, 2000b, p. 25)

FARRE explains: "It is thought that elementary particles, e.g. quarks and electrons, are the consequences of the interaction of virtual particles created by local **fluctuations** of the quantum vacuum"(Ibid)

Of course: "How radiant energy, which is not localised, suddenly condenses in one place (e.g. as in a pair (of particles production) is a profound mystery..."

"Equally mysterious is the reverse **process**, whereby **condensed energy** dematerialises and radiates, as in the case of the annihilation of positronium into two gamma rays under conservative **constraints**"(Ibid)

More mysterious still is why any question answered in sciences generates a new question, generally still more difficult to answer, as if our brain-mind could only generate an unending spiral of riddles

→ Gödel's incompleteness theorem

2704

QUARTER POWER (SCALING LAW of)

→ Scaling (Law of quarter power)

2705

QUASI-PERIODIC ²⁾

Condition of a **process** or system which never repeats itself perfectly, but only nearly perfectly.

Quasi-periodicity is typical of **complex systems** and closely related to **chaotic determinism**.

Quasi-periodic **processes** or systems are never perfectly predictable. Their **behavior** can however be forecasted within more or less narrow **limits**. This kind of **predictability** has been called "**asymptotic predictability**".

2706

QUASI-SPECIES ^{1) - 5)}

M. EIGEN defines the quasi-species as a **population** of molecules of similar composition (1992).

The concept seems applicable to **homogeneous populations** in general.

Different quasi-species may have distinct rates of correct **replication** in different **environments** and in this way, they become subject to selective influences and start to diverge from each other.

2707

QUEUEING THEORY ⁵⁾

An **Operations Research** theory (and **methodology**) used for the study of the **effects** of congestion in waiting lines.

This can be done by using specific mathematics and computer **simulation**.

Congestion however is also a **cybernetic phenomenon**, which relates to **channels capacity**, **flows velocity**, **turbulence in flows** and **networks dynamics**.

2708

QUORUM SENSING ²⁽⁴⁾⁵⁾

A chemical signaling **mechanism** that bacteria use to find out if they are by themselves or one of a crowd (G. WATTS, 2003, p. 30)

More generally collective **reaction threshold** in a **population** signaling the onset of a common **behavior**.

It could very well be a fundamental condition of any socialized **behavior**. It seems to be the result of increasing **density**, the consequent reduction of interindividual distances and the increasing reciprocal **perception** of **signals**. These can be biochemical, physical, visual, or other.

J. MARCHANT reports an example observed by G. WEGRZYŃ on marine bacteria (2000, p.8)

WATTS explains: "Each individual secretes into the **environment** a low level of a certain chemical, for which it has surface receptors. The more bacteria that are around and pumping out this chemical, the higher its local concentration and the more the cell surface receptors are stimulated..."

"The quorum" part of the name reflects the bacteria's need to be present in sufficient numbers to make it worthwhile to behave in a particular way, just as a political meeting needs to be quorate to take decisions. The **decision** bacteria need to make is whether or not to turn virulent"(p.30)

The somewhat metaphorical and anthropomorphic way to describe this **process** does not detract from its deep systemic significance: it amounts to the discovery at a very elemental biological **level** of the same process of **socialization** through density of **interactions** that also shows in ants, bees or locusts **behavior**. And of course, the appearance of a superior level of interactions through **informations** systems of various type in human kind is still another example of this very general process. Its systemic (and **transdisciplinary**) meaning is obvious.

→ Co-orientation; Density (critical); Dictyostelium discoideum; Effects (mass-); Field (Social); Flocking ; Herd effects; Implosion; Organizer; Overcrowding; Pheromone; Proximity; School; Stigmery; Swarm

R

2709

RADIATION (Self-contained) ¹⁾

Evolutionary radiation, i.e. the appearance and **differentiation** of various new types from a common origin in **time**, is a feature of **evolution** in general, i.e. not only of living beings, but also of **artifacts** and human **organizations**.

Moreover new types retain most of the fundamental characteristics of the original type and, at least in **living systems**, no new fundamental types seem to have emerged independently since the beginnings of life. If the same is true for **artifacts** is debatable, because there seems to be a complex recombination of characteristics among types and even new independent beginnings (electricity, nuclear energy for example).

The general **representation** of the succession of types is accordingly a unique **tree** fractalized along the **time** dimension, that could be inscribed within an overall containing funnel form.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

2710

RANDOM¹⁾

In G. BATESON words: "A sequence of **events** is said to be random if there is no way of predicting the next event of a given kind from the event or events that have preceeded and if the system obeys the regularities of **probability**" (1979, p. 30)

He adds "Note that the events which we say are random, are always members of some limited **set**" (Ibid)

Absolute randomness is either experimentally fabricated, for example by throwing dices, or a mathematical **model**. It has been discovered that **randomness** is generally merely relative in observed events and corresponds to **deterministic chaos** or **self-organized criticality**. Absolutely random events would be possible only in the absence of any **constraints**, internal or external.

2711

RANDOM ACCESS⁵⁾

In a computer the retrieval **process** of **data** from the **memory**, which does not depend on the **memory** address.

2712

RANDOM NUMBER²⁾

Any number that cannot be generated by an **algorithm** shorter than the number itself.

According to KOLMOGOROV, "...a number is random if the shortest **program** for calculating its **digits** turns out to be about the same length as the number itself". In other words, a random number cannot be compressed, i.e. reduced to such a **program** (D. MACKENZIE, 1999, p.45).

Of course, this leaves a doubt: A shorter **program** could possibly exist, but not being yet discovered by someone.

→ **Complexity (Algorithmic); Garden of Eden**

2713

RANDOM PHENOMENON^{2) - 3)}

"A phenomenon which associates in a common **structure** a **set** of elementary phenomena ("microscopic") and a **macroscopic** phenomenon, in such a way that the evolution of last one is conditioned by the cumulated effects of the former ones" (J. BONITZER, 1988, p.82).

BONITZER comments: "Such a definition probably seems strange... (it is that) it does not consider **probabilities** in the first place as elements of a **representation** (as if it were from a positivistic philosophical angle), but on the contrary the random phenomena themselves, as elements of a **reality**."

In other words, a random phenomenon is a sum of **events** or **behaviors of the same nature**.

In opposition with the individual **event**, the phenomenon is all-embracing at a more general **level** (and refers frequently to a system or a systemic **process**).

This view of randomness is coherent with **deterministic chaos**.

2714

RANDOM PROCESS^{1) - 2)}

The concept of random process is somewhat obscured due to the fact that the role of **time** (past, present, future) is generally not well understood.

P. VENDRYES states: "As an experimental example one can take the throw of a dice. This is a random process... It is datum of common experience that the throwing of a dice occurs in *two stages*. During the first stage the player makes a choice (a bet) of one of the six faces of the dice. These are therefore six simultaneous alternatives available to the player. This multiplicity of alternatives makes the process **indeterminate** and **unpredictable**. The second phase occurs when any one of the six faces turns up, so excluding the other five. *This exclusion makes it an irreversible process*. Thus, there are three attributes of a perfect random process: multiplicity, **unpredictability** and **irreversibility**."

"The random process distinguishes itself from the **deterministic process** during the first stage by the multiplicity of **simultaneously** possible outcomes. Each of these cases has a certain probability of turning up. The **probability** belongs to the *first stage* of the random process, before its realization; it is *virtual* because the second stage has not yet taken place; it is oriented towards an unpredictable future, and it is *transient* because it disappears as soon as the second stage takes place." (1989, p.14)

VENDRYES' concept is clearly related to **Bayesian subjective probabilities**.

From another viewpoint, R.V. JENSEN writes: "Attempts to reconcile the probabilistic laws of statistical mechanics give birth to a new branch of mathematics, called **ergodic** theory, which provides a means of classifying different **deterministic dynamical systems** with irregular **behavior**. In particular, this **classification** scheme defines symptoms for a **hierarchy** of different **classes** of random **behavior**, "statistical diseases" of increasing severity" (1987, p.176).

Ergodic systems allow for **randomness** within a general **determinism**. Further along, **chaotic systems** seem completely random, but still possess an underlying **determinism**. It becomes thus necessary to consider that pure **determinism** and pure **randomness** are only idealized abstract conditions.

These are reasons why collected statistics on the past of a random process do not allow a precise and secure prediction of any future **situation**.

2715

RANDOM RELATION^{1) - 2)}

"The relation between two systems who are independent from each other" (P. VENDRYES, 1973).

In VENDRYES words: "Relations between two systems are **deterministic** when they are connected and random when independent from each other" (1973, p.7). "Independent" here means that both systems are determined by causes which are not linked.

A similar random relation exists when a system suddenly receives unforeseen **inputs**: somebody travels to some place and, precisely there is killed by an earthquake.

A defined relation starts to establish itself when the **contact** is established and is thus in many cases largely unpredictable. This concept has produced recently in France the appearance of consultants who scout still ignored new technological developments which could later influence existing enterprises.

2716

RANDOM SEARCH PROCESS⁵⁾

A process of active probing of possible **configurations** within a **network**.

According to R.W. FULLER and P. PUTNAM such processes appear in **networks** when there is a **drive factor**. They tend to the formation of areas of relative **dominance**.

These authors state: "What stops a random search is reinforced again and again – everytime the associated **drive factor** is excited – because what satisfies a **drive factor** once will do so again if it catches the basic principle involved. Such **correlations** are **invariant** in the sense that if the random search is re-excited, the same stable **configuration** of nervous activity dominates" (1967, p.105).

This confirms independently HEBB's view on **habitation**.

This type of processes is probably at work in any kind of **networks**, nervous or other.

2717

RANDOM WALK²⁾

An exploration of some **concrete** or **abstract space** without any determining **guidance**.

S LEVY reminds us of the probability theorem that states that "Starting from any point in a random walk restricted to a **finite space**, we can reach any other point any number of times" (1992, p.303).

The condition for a random walk is that no **attractor** should exist within the **space** considered or, in other words, that no **gradient** be present.

Once some **reinforcement** factor appears within the explored **space**, the "explorers" search tends to become organized. This is basic for the appearance of **self-organization** in **networks**, for instance of **social robots**.

It is also the case for many *seemingly* aperiodic **oscillations**: markets **fluctuations** for example cannot be satisfactorily modeled by random walks, because while their **behavior** is **chaotic**, it is however *not* perfectly **undetermined**.

In human generated more or less **periodic processes** (for ex. stock markets evolution) a loosely **deterministic factor** is present and active. This factor is psychological in each participating individual, but at the same time psychosocial among the **group** of investors as a **whole**. Markets, for ex. are not only fluctuating in relation to economic indicators, but also according to investors and speculators moods and **beliefs**, as they are not purely rational **agents**, nor omniscient.. If the majority are optimistic, the prices rise; if they turn pessimistic, the prices fall.

Moreover the shifts present two other defining characteristics:

- they are **self-organizing processes**, with critical **thresholds of instability**
- as shown by ELLIOTT in the 1930's, **long term** movements can be graphically split into alternating medium and short component **waves** which appear to be grossly **self-similar**.

→ ELLIOTT's waves; Self-similarity in the WEIERSTRASS function

2718

RANDOM-CHOICE PROCESS ^{1) - 5)}

According to H.T. ODUM: "... speciation like other creative work involves a random-choice generating **process**, followed by a choosing system" (1971, p.159). ("choosing device" would be possibly a more suitable term).

ODUM explains: "New species are formed when new **adaptations** receive better **loop reinforcement** and **reward** from the system in which speciation is occurring". Here, the "system" is obviously the **ecosystem**, or **environment**.

ODUM adds: "... species are developed for the compatibility of systems. The systems view regards concurrent speciation as a coordinated **adaptation** to evolving **networks**... Speciation is best considered as the **process** of adapting **parts (populations)** to evolving systems. In human affairs the **evolution** of specialized industries with their specialized occupational **populations** is an equivalent **process**: each industry receives its selective **reinforcement** according to its economic reward for contribution to other **circuits**" (Ibid).

The choosing device tends thus to reinforce the **network's coherence** and, eventually to expand its scope.

An interesting parallelism can be traced with P. VENDRYES' concept of **autonomy** through probability **selection mechanisms**.

2719

RANDOMNESS ^{1) - 3)}

1) The non-**causal correlation** between successive **events**

2) The character of any collection of **objects** that cannot be simplified through any ordering device.

J. CASTI defines randomness as "maximally complex" (1994, p.9). This does not seem to be adequate, as **complexity** most generally evokes **order** in systems. It would be better to consider "random" as maximally *complicated*, i.e. **algorithmically incompressible**, as CASTI himself states (Ibid).

The 19th century French philosopher A. COURNOT defined it as "the crossing of independent causal series". Independent, that is, within the limits of our **knowledge**.

In effect, this generic term covers various different meanings, as shown by M. BODEN who distinguishes at least three: "**Absolute randomness** (A-randomness, for short) is the total absence of *any order or structure whatsoever* within the **domain** concerned, whether this be a class of **events** or a set of numbers (It is notoriously difficult to define A-randomness technically, but for our purposes this intuitive definition will do).

"**Explanatory**" randomness (E-randomness) is the total lack, in principle of *any explanation or cause*... If an **event** is A-random, it must be E-random too. (Since explanation is itself a kind of **order**, A-randomness implies E-randomness) It follows that it is often unnecessary to distinguish between them...

"**Relative**" randomness (R-randomness) is the lack of any **order** or **structure relevant to some specific consideration**. Poker-dice, for example, fall and tumble R-randomly with respect to both the **knowledge** and the wishes of the poker-players... In practice, R-randomness is always identified by reference to something people might have regarded as relevant" (1990, p.223).

In other words, randomness, like **determinism** seems to be an explicative categorization (not much explicative, at that). This appears clearly in the following comments.

J.von NEUMANN (as quoted by B. HAYES) wrote (in 1951!): "Anyone who considers arithmetical methods of production random digits is, of course, in a state of sin" (1993, p.114). von NEUMANN insisted that there are no such a thing as random numbers "per se" and that the production of a series of so-called random numbers through some "strict arithmetic procedure" was in fact equivalent to the use of an **algorithm**, which is of course entirely **deterministic**.

As shown by HAYES such **algorithms** may in fact generate series of "pseudo-random" num-

bers. However, after a sufficient number of runs, the **algorithm** will start to repeat the same numbers.

The objective reality of randomness in itself may even be debatable. J. BONITZER observes: "... in order to find a probability or a distribution of probability in a random series of **observations**, such a series must unavoidably have been constituted in some way or other (it is not simply given) - and by whom, if not by the *observer*, who must at least, consciously or not, decide to accept it? It cannot be helped, seemingly, that the **observer** pops up, precisely where he was supposedly be eliminated" (1988, p.49).

From this viewpoint, it is noteworthy that all random **games** (dice, roulette, etc...) are *constructed* and produce quite predictable probabilities, for the major profit of any games organizer.

No **phenomenon** is without causes - in plural. The complex mix of numerous concurrent causes at any moment in the **behavior** of **complex systems** generates *deterministic chaos*, which offers the general appearance of **random behavior**.

In D. BOHM and F.D. PEAT's words: "Randomness is thus understood as the result of the **action** of the very small **elements** on each other, according to definite **orders** or laws in an overall **context**" (1987, p.131).

→ **Complexity (Algorithmic); Random Number**

2720

RANDOMNESS (Constrained) ¹⁾

The limitation in randomness which results from the **scaling process**.

The **scaling process** defines more and more precise **limits** for the possible position of any **structural element** in a system (which may be for example the bronchioles in the lung, or a fine detail in the **representation** of the **WEIERSTRASS function**).

At any **level**, it is still impossible to exactly pinpoint the position of the **element**. In other words, randomness never disappears completely, but can be evermore reduced in **space** as well as in **time**.

This gives a firm base to the **concept of ergodic relation**.

From the viewpoint of the **WEIERSTRASS function**, the remaining randomness at any **level** corresponds to the impossibility to differentiate the function at any **time**.

It should however be noted that this randomness constrained by **scaling** excludes the case of giant **fluctuations** in **systems far away from equilibrium** (or possibly, such giant **fluctuations** do manifest the **emergence** of **scaling** at a higher level).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2721

RANDOMNESS (Pseudo)²⁾

The character of a sequence of apparently random numbers created by using some specific **rules**.

Such a *constructed* randomness is of course not really random. As already observed by J.von NEUMANN, it is possible to generate an apparently perfectly random series of numbers in a completely **deterministic** way... which is exactly the contrary of randomness, even if it is possible to introduce an "asymptotic decrease toward 0 of the self-correlation function of the numbers in the series", as expressed by S. DINER (1992, p.350). As this implies a kind of "loss of **memory**" of the **initial conditions** (Ibid) the relation with **chaotic dynamics** is evident.

2722

RANDOMNESS REDUCTION¹⁾

According to R.W. FULLER and P. PUTNAM any **learning process** should be considered "... as a reduction in the randomness of sequences of **behavioral elements**" (1967, p.104)

This effect is obtained through a **random search process** which tends to the formation of more or less local **relative dominances**, i.e. by the establishment of stabilized **patterns**.

While these authors are mainly concerned with the **brain**, this model seems applicable to any **network** in its **organization process**.

2723

RANDOMNESS (Restricted)³⁾

Systemic randomness, i.e. randomness within a system is, by necessity, limited. A system totally submitted to randomness could have no internal **order** at all, and thus could not be a system.

Systemic **organization** is possible only by way of **constraints**, i.e. the existence of admissible (authorized) **connections** among **elements** or **subsystems**, combined with impossibility (or prohibition) of other **connections**.

Constraints tend to become differentiated in different areas of the system. In this way, degrees of **order** and randomness become locally distributed.

As the system as a **whole** can remain performant only as long as its specialized **processes** and **subsystems** function in a non-contradictory way, there is a paired restriction to randomness among **levels**:

1°- The **subsystems** and specific **functions** tend to become better interconnected and compatible.

2°- The system as a whole imposes to its **parts** its basic determined conditions of survival.

Randomness is also functionally limited: any system or **subsystem** has only a limited **repertory of responses** to specific **stimuli**, and even only some of these **responses** are the most probable ones.

ASHBY's experiment, with **homeostats** (1960, p.100-121) demonstrated, moreover, that even a **machine** specifically constructed to produce random **behavior**, tends towards at least statistical **stability**, provided it is constructed as a **net of subsets**, submitted to some **rules of interconnections**. Without these last ones, there can be no **coherence** whatsoever, while, of course, the **rules** introduce a measure of constraining general **determinism**.

The most typical random-restricted systems are the **ecosystems**, where, within the **limits** of global **determinism** imposed by geophysical **cycles**, numerous vegetal and animal interconnected **populations** fluctuate in ways practically unpredictable.

Respect to the **environment**, systems are "anti-random", using, as demonstrated by P. VENDRYES (1942) specific **reserves** to counteract perturbing variations imposed upon them. This **concept** is obviously related to ASHBY's **Law of Requisite Variety**.

2724

RANGE¹⁾

"The **set of states** onto which **transitions** are defined" (K. KRIPPENDORFF, 1986, p.63).

A problem with many **processes** in **concrete systems** is that their range is ill-defined or not defined at all, and difficult to establish. This complicates **decision-making**, and still more so when the range is not **stable**. A good present example is the hypothetical range of the greenhouse effect in global and regional climate.

2725

RATCHET¹⁾

A mechanism consisting of a pawl, or hinged catch that engages sloping teeth on a wheel, allowing for rotation in only one direction.

Such a mechanism introduces an intermittent stop and go **process**. It is generally related to a step function. It produces discontinuous **phase transitions**, passing through a succession of **critical states** which trigger sudden jumps after periods of apparent **stability** that can be quite long.

By analogy the ratchet can be seen as a device that secures **irreversibility** of intermittent processes and may lead to incrementally accumulative effects. In fact, it tends to block negative or counter active **feedbacks**.

In a sense it can be regarded as a kind of anti-regulator.

2726

RATE¹⁾

The **level** of production per unit of **time** in a **process**.

Rates can be constant or **variables**. When variable they can vary periodically or in an irregular way.

In his **Systems Dynamics**, J.W FORRESTER uses **flow** rates in a very specific way, to define the present, *instantaneous flows* between the various **levels** (i.e. operative **processes**) in the system. There is generally a **feedback** between the **levels** and the rates. The **flow** rates are determined by the **levels** in accordance with the **rules** defined by the **decision functions**. Conversely, the **flow** rates will determine the **levels**. The global results could possibly alter the global **decision-making**.

2727

RATIO SCALE²⁾

A way to represent **growth** graphically.

On such a scale equal vertical distances represent equal percentage **change** (fig. a and b from E. DEWEY and E. DAKIN, 1950, p. 242)

The simple arithmetic representation shows **growth** in absolute terms. The apparent accelerating growth hides the fact that relative growth is merely constant.

The ratio scale is also known as **semi-logarithmic scale**.

→ **Growth (Explosive or exponential); Optimum (Dynamic)**

2728

RATIONALITY ACCORDING TO DESCARTES³⁾

René DESCARTES stated in the following way the four precepts which are basic according to him for one to "conduct correctly his reasoning and seek *truth* in the sciences":

"... never to accept anything for true which I did not *clearly* know to be such;

"... to divide each of the difficulties under examination into as many **parts** as possible, and as might be necessary for its adequate solution.

"... To conduct my thoughts in such order that, by beginning with **objects** the simplest and easiest to know, I might ascend by little and little, and, as it were, step by step, to the **knowledge** of the more complex; *assigning in thought a certain order even to these objects which in their own nature do not stand in a relation of antecedence and sequence*.

"... in every case to make enumerations so complete, and reviews so general, that I might be assured that nothing was omitted." (1947, p.175-6) (Translation by Saxe COMMINS and Robert N. LINSKOTT, 1947).

This famous text certainly justifies some comments from a systemic viewpoint:

1. DESCARTES "seeks **truth**", but the hereafter quoted sentence seems to show that his **model** of "**truth**" is geometry's one, i.e. the **truth** of an abstract conceptual **construct**, or in other words, a **model** or, at most, an **algorithm**. The problem of **ontological truth** is not solved (neither is it by systemics, but at least, it is clearly stated: reality is "veiled" (B. d'ESPAGNAT, 1985)

Immediately after enouncing his four precepts, DESCARTES says: "The long chains of simple and easy reasonings by means of which geometers are accustomed to reach the conclusions of their most difficult demonstrations, had led me to imagine that all things, to the **knowledge** of which man is competent, are mutually connected in the same way, and that there is nothing so far removed from us as to be beyond our reach, or so hidden that we cannot discover it..." (p.176)

2. The word "clearly" (in DESCARTES text in French: "évidemment" = "evidently") and, of course, the whole of the first precept, places DESCARTES, just as any one of us, in the **observer's** position, that he does not examine. Moreover, DESCARTES was not able – as we ourselves are now – to distinguish "evidence" by direct **perception** and "evidence" technically constructed (as for example when physicists use a particles accelerator).

Finally, the notion of "evidence" becomes quite nebulous when it refers to the human affairs, unavoidably scrutinized by **observers**, quite different from each other psychologically and culturally. Inevitably, rationality becomes more or less subjective and tainted by **values**.

3. The second precept contains the seeds of the whole **reduccionist** research **method**, of extraordinary **efficiency** when applied to reducible **phenomena**, but which inconveniently eliminates the complex **interactions** between **elements** and **processes**.

4. The third precept tends to obviate this inconvenient, but the experience of three and half centuries shows that complex **interactions** generally cannot be again pieced together in such a way and thus remain ignored.

The last part of this precept shows that DESCARTES was conscious of the multicausality problem as well as the one about **simultaneity**. However, he does not say us how his "thought assignment" may lead to the discovery of this **order**, of which he reasonably presumes the existence.

5. The last precept cannot, unfortunately, guarantee us that we did not omit something. Moreover, while it seems to herald the statistical **method**, it does not contain anything related to the reduction of **variety** by way of statistics.

2729

RATIONALITY (Bounded)^{3) - 4)}

The limited degree of rationality in **decision-making** due to the limited computational abilities of the decision-maker.

This concept was established by H. SIMON (1969, p.214-29). As stated by J. CASTI: "SIMON assumed that economic agents can never make truly **optimal decisions** because they are inherently limited in the amount of **information** that they can process prior to having to make a **decision**. Accordingly, for SIMON, all **decisions**, economic or otherwise, generally lead to a nonoptimal "satisficing" kind of **behavior**" (1990, p.231).

As a consequence, SIMON finds it very important to reduce the extension of what must be computed: "... if an **organism** is confronted with the problem of behaving approximately rationally, or adaptively, in a particular **environment**, the kinds of **simplifications** that are suitable may depend not only of the characteristics – sensory, neural, and other – of the **organism**, but equally upon the **structure** of the **environment**" (1969, p.215).

It becomes thus of paramount importance to establish efficient **criteria** for structural **simplification** of **situations**, without losing their really significant characteristics. The nature of of an efficient structural **simplification process** appears clearly through SIMON's parable about **Hora and Tempus** watchmakers.

Most generally, the two opposite aspects to be taken care of, for **simplification** previous to **decision-making**, are the necessity of **maintenance conditions** of the system and the need for sufficient **degrees of freedom**.

2730

RATIONALIZATION (Spurious)²⁾³⁾

In many cases our acquired mental and in particular logical **frames of reference** are used to produce arguments that look rational, i.e. apparently deduced in a satisfactory way. However, our supposedly rational reasoning is frequently bended and distorted by implicit prejudices, or by **ideologies** of some kind, of which we may even be unaware.

Beliefs of any kind should be closely scrutinized in order to avoid fooling ourselves and risking to run into unadverted problems.

→ **Assumptional analysis; Awareness, Falsifiability; Observation (self-); Underconceptualization**

2731

REACTION DELAY²⁾

"The **span of time** needed for a **control** to register a **disturbance** and produce a **response**" (B. WALLISER, 1977, p.97).

The **response** not being instantaneous, the delays themselves can introduce **disturbances** into the **process** and complicate the **control**. This in turn may increase the cost due to an excessive use of the **control**. Fine tuning of any **control** must thus evaluate the effects of reaction delays and take them in account.

2732

REACTION of a system¹⁾

"A system **event** that is deterministically caused by another **event**" (R.L. ACKOFF, 1972).

The causal **event** is thus necessary, but also sufficient to produce the **change** of **state**. In such cases, the **behavior** of the system is strictly passive: it has no possibility to modify it, i.e. it is in a no **autonomous situation**.

2733

REACTION-DIFFUSION SYSTEM²⁾

A system dominated by opposed **sets** of forces, of which one tends to amplify differences and the other one to dampen them (After M. BUCHANAN, Inside Science Nr.121, p.3)

This type of reactions appear in systems in **process** of **dissipative structuration**, as for example the Belousov-Zhabotinskii reaction. They lead to the appearance of typical **patterns** of **growth**, as **hexagonal structures**, **TURING structures**, or **fractals**.

2734

READINESS (Conditional)¹⁾

This a conditional **potential** for **behavior**, more subtle than the behaviorist's conditioned **behavior**. D M. Mac KAY proposes this notion as follows: "Suppose... someone tells you "it's raining". You may be immersed in a book, and may not feel inclined even to grunt an acknowledgement. But this does not mean that your **understanding** of the **message** has had no effect on you. If a sudden call comes for you to go out of doors, you may now be ready to reach for umbrella or mac... What has been affected by your **understanding** of the **message** is not necessarily what you do – as some behaviourists have suggested – but rather what you would be **ready** to do *if* given (relevant) circumstances arose. It is quite possible that relevant circumstances may never arise, so that a naively behaviouristic approach would reveal no sign that you had understood the **message**. It is not your **behaviour**, but rather your **state** of **conditional readiness** for **behaviour**, which betokens the **meaning** (to you) of the **message** you heard" (1969, p.22).

2735

REAL WORLD PROBLEM

→ **Problem (Soft)**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2736

REALISM (Experiential)³⁾

Within the general frame of the new field of cognitive science, G. VOLLMER, quoted by H. TOTH thus explains the basic tenets of experiential realism:

"a) a commitment to the existence of the real world

b) a recognition that reality places **constraints** on concepts

c) a conception of **truth** that goes beyond internal **coherence**, and

d) a commitment to the existence of stable **knowledge** of the world.

...Experience here is taken in a broad rather than a narrow sense. It includes everything that goes to make up actual or potential experiences of either individual **organisms** or **communities** of **organisms** – not merely **perception**, motor movement, etc., but *especially* the internal genetically acquired makeup of the **organism** and the nature of its **interactions** in both its physical and social **environments**" (1983, p.XV – in TOTH, 1983, p.307).

These concepts are quite akin to PASK'S **conversation's theory** and von FOERSTER'S **cybernetics of 2nd order**.

→ **Realism, hypothetical and Ontological skepticism**

2737

REALISM (Hypothetical)³⁾

D.T. CAMPBELL stated in 1961: "My general orientation I shall call a hypothetical realism. An 'external' world is hypothesized in general, and specific entities and **processes** are hypothesized in particular, and the observable implications of these hypotheses (or hypostatizations or reifications) are sought out for verification. No part of the hypotheses has any 'justification' or **validity** prior to, or other than through, the testing of these implications" (1961, p.17).

However, CAMPBELL did not yet consider the deeper nature of 'verification' or 'justification' or '**validity**'.

It was more or less at the same time that G. PASK, H.von FOERSTER and others started to scrutinize the role of **observers** and of their acquired and constantly renovated **consensus** in the **knowledge** of reality.

G. VOLLMER, quoted by H. TOTH thus explains the main tenets of hypothetical realism (1992):

"All **knowledge** is hypothetical, i.e. conjectural, fallible, preliminary. There exists a real world, independent of our **consciousness**; it is structured, coherent and quasi-continuous: it is at least partially knowable and explainable by **perception**, experience and intersubjective science..." (p.28 – in TOTH, 1983, p.307).

Knowledge is thus based on **consensus**, but is somehow anchored in reality and verified or falsified by experience. However no result is ever absolute, as already explained by POPPER.

2738

REALISM (Structural)²⁾³⁾

This concept was introduced by H. POINCARÉ (1894-1912) (1902, p. 248-71). It sustains that the relations discovered through theories that have been systematically confirmed, do reflect "real" aspects of the physical world, as it is, independently from man" (L. SOLER, 2001, p. 82)

It is noteworthy that in her critical note, SOLER still puts "real" within quotation marks and uses the word "reflect"

In fact, there is a quite general **consensus** among epistemologists who examine the validity of scientific endeavor: our **knowledge** of the outside world is always relative to our human perceptive abilities and to our conceptual capacity for constructing models in our **nervous system**, and specially in the neo-cortex in our **brain**

2739

"REALITY" (Riddle of)³⁾

B. GAINES considered this riddle in a 1984 paper, in which he considered the problem of **modeling** "reality" (the unique way we have to learn something about it): "... the most outstanding characteristic of human kind is that we all are, and always will be, **modellers**" (1991, p.356).

Our problem is thus to try to evaluate our "Groping in the dark" (MEADOWS, D., et al – 1982).

GAINES finds and discuss three basic **modeling** attitudes (1977, p.358-65):

"- ZERO: There is no **method** of reality;...

"- ONE: There is one correct **method** of reality;...

"- MANY: There is an indefinite **variety** of **methods** of reality"

The first attitude corresponds to radical skepticism; the second one to any exclusive **modeling methodology**; and the third one, to a kind of positive experimental scepticism.

E. SCHWARZ writes: "We were led to the idea that "reality" cannot be reduced to the physical world, but that it has two equally "real" aspects: the usual physical world of **objects**, where **energy** is the pertinent **parameter**, and the logical world of **relations**, where **information** is the relevant **parameter**" (1992, p. 773).

In accordance with this view, what we call reality is a combination of **energy** and **information**. (itself merely modulated **energy**) for the human **observer**, able to construct such a **model**.

It could be added that "reality" has obviously different **meanings** in different cultures: see for example "La Pensée Sauvage" by Cl. LEVI-STRAUSS.

This matter is very much relevant for **systemics**, because is becomes a firm foundation for the concept of **models**, which merely aim at *representing* reality.

N. LUHMANN'S view, as interpreted by O. THYSEN (1995, p. 15) is that: "Reality" is only real in so far as it is observed reality, and no system has access to any "real reality". WITTGENSTEIN made the same point in a different way. A good example is the sight of stars at night. It is the human **observer** which creates a "celestial show" out of a complex set of luminous sensations resulting from light emissions from thousands of stars, completely **heterogeneous** in the **space-time dimension**.

In this example, it should be noted that:

1- the picture of "reality" is always slightly different for two or more observers

2- no reconstruction of "real reality" would ever be possible because it is absolutely fleeting as time is "running on"

→ **Ontological skepticism**

2740

REASON³⁾

"A manifestation of articulated belief, as reflected in the presence of tangible, visible, expression of that belief" (J. WARFIELD, 1989, p.11).

This is kind of an operational definition, to be used in **Interpretive Structural Modeling**, as proposed by WARFIELD. (The ultimate nature of reason is, of course, a very controversial subject, that cannot be discussed here).

WARFIELD adds, interestingly: "More generally, reason will be seen as high in quality when the form of its expression is not chosen intuitively in deference to **habit**, but is specifically tailored to satisfy recognized and articulated **communication** needs. Conversely it will be seen as low in quality when the form of its expression is colloquial and indifferent to the requirements of **description** and audience" (Ibid, p.12).

However, reducing the satisfactory manifestations of reason to its communicatory quality obviously is of course far from exhausting the subject.

2741

REBOUND EFFECT¹⁾⁴⁾

A positive **feedback** effect of some innovation on a specific **process**.

For example it frequently happens that a technical **progress** that helps to produce some commodity at a lesser **cost** and with a reduced use of **energy** or raw materials, induces a higher consumption of the product. This leads of course to an increase in uses of energy and

raw materials. A well known example in the 19th Century was the enormous increase of steel consumption after the invention of the BESSEMER process. During the 1980s and 90s, we have witnessed the replacement of big-frames computers by tens of millions of personal computers. Of course, as a result, the use of all kinds of **inputs** increases on a global **scale**. Accordingly, it is in no way certain that technical progress necessarily leads to a better global **sustainability** (See, for ex., the recent "Stuttgart Charta on Information Society and Sustainability" - Forum Info 2000 Bonn - July 2nd, 1998).

A sociology of the uses of **artifacts** would be a very needed complement to progresses in technologies in order to reach a better global **evaluation** of technologies weight in global human **ecology**.

Rebound effects have also been observed in demography: After great hecatombs through **pandemics** or war, the birth rate frequently surges and compensates the losses quite quickly. The same **effect** can be observed for instance in burnt down forests. Rebound effects are thus an obvious feature of **complex systems**.

In most cases, rebound effects come as a surprise to the **observers**.

2742

RECAPITULATION

→ **Complexity (Accumulative)**

2743

RECEPTOR ¹⁾

Natural organ or artificial device able to register certain **signals** and to transform them into a **code** acceptable to the system.

The term, originally a biological one, was used by A. LOTKA (1956, p.363-5), but never entered in widespread use. J.G. MILLER uses the term "**input transducer**", which he limits to the devices able to register **elements** of **information**.

According to A. LOTKA, the receptors are the initial **elements** of the devices he called "**depictors**", needed by systems to obtain a **representation** of their **environment**. The receptors transmit the results of their **perception** to the "**elaborators**" (p.363-65).

2744

RECIPROCITY ²⁾⁴⁾

"A mutual or cooperative **relationship**".

Reciprocity is, of course, possible only when the **relationship** is sufficiently repetitive.

Such a **situation** exists, for instance, in specifically connected **neurons** in **neural networks**, or in people interacting frequently with each others in **groups** of limited **size**.

It generally seems to be a pre-condition for the shaping of wider **cooperation** in **social systems**, human or other.

Reciprocity is of course a **feedback**, and can be positive as well as negative, in both senses of an acceleration or deceleration **process**, or its favorable or unfavorable results, in a psycho-sociological **meaning**. (See: A. RAPOPORT on Games theory, 1959)

→ **Tit for tat strategy**

2745

RECOGNITION ¹⁾²⁾⁴⁾

The adaptive and **continuous correlation** of **elements** in a give physical **domain** to the new **events** taking place in another physical domain more or less independent of the first one (G. EDELMAN, 2000, p.109)

EDELMAN adds: "These **adjustments** take place without any previous instruction, through **selection** within a hypervariable **set**.... These recognition systems are based on similar principles..."

- there is a **variety** (in french: "diversité") **generator** inside the internal domain
- there is an **interaction mode** between the external domain, and the various **repertoires** inside the internal domain
- there is a differential **amplification** of some **elements** of the internal domain" (Ibid)

This last principle is concurrent with RUMELHART & Mc CLELLAND'S **Parallel distributed processing**.

EDELMAN gives the following examples: "In immunology these two domains are obviously antibodies and antigenes. In **development** they are the genetic and the epigenetic (i.e.: cellular **environment**). In the neuro-sciences they are dynamic **neuronal structures** and **sets** of **informations**, or **stimuli** originating in the external world" (Ibid)

MATURANA would probably accept "stimuli", but reject "information": the world is as it is and there is no information without a **brain**.

For EDELMAN, the brain is a **network**. In the quoted interview (as in his former works) he develops his **model**.

Cooperative or associative behavior cannot work if the elements cannot somehow "recognize" each other.

This is specially true in complex **relationships** in **groups**.

The deepest nature of so-called "recognition" is however quite enigmatic.

While it would be highly anthropomorphic to say that atoms of hydrogen "recognize" atoms of oxygen, or chlorine as possible "associates", it is however obvious that chemical valencies that imply potencial **complementarity** have in a very basic sense a social **meaning**.

Characteristic significance by associative capacity through some forms of **compatibility** and complementarity does also emerge all along biological **levels**, for ex. from enzymes on.

2746

RECOGNITION BY INFERENCE ^{3) - 5)}

The capability to recognize **patterns**, figures, objects or people is a property of **neural networks**.

Fr. CRICK and Ch. KOCH give the following example and explain it: "If you look at a person whose back is turned to you, you can see the back of the head, but not the face. Nevertheless your brain infers that the person has a face. We can deduce as much because, if that person turned around and had no face, you would be very surprised.

"The viewer-centered **representation** that corresponds to the visible back of the head is what your are vividly aware of. What your **brain** infers about the front would come from some kind of three dimensional **representation**" (1992, p.112).

Of course, such three-dimensional **representation** is present in our cerebral **network** as a very basic feature, acquired during the infancy. It seems moreover that there is more to it than this: We also should be very surprised if that person would have a cat's or dog's face, which implies that we have a somehow permanent category of "human beings" in our neural **network**.

Moreover, the nature of our internal and potential **representations** obviously depend of our **cultural training**. We easily recognize the **symbols** of our culture (say: the Cross, the Crescent, the Mandala, our flag, etc...), but do not recognize at all or easily **symbols** of other cultures.

2747

RECOMBINATION ¹⁾²⁾⁵⁾

A process of generation of new **elements** or new **rules** in an **adaptive system**.

The system may be a biological species, a genome, an artificial life unit, or a **pattern recognition** device, or even conjecturally a **set** of **memes**..

In J. HOLLAND's terms recombination "implements" a "pervasive **heuristics**" (1992, p.197)

In nearly all cases, recombination may affect in a positive way the adaptive character of the **goal-seeking system**, because "it provides a powerful **mechanism** for discovering and exploiting useful **schemata**" (Ibid. p. 191).

However, in some cases, it may have negative **effects**, as in the **conjugation** of two similar recessive pathogenic alleles.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

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RECONSTRUCTABILITY ANALYSIS²⁾

"A set of computer aided methodological tools for dealing with the **relationship** between **wholes** and **parts**, i.e. between overall systems and their various **subsystems**" (G. KLIR, 1991, p.141).

KLIR, who created and developed this **methodology**, states: "At the highest level of generality, reconstructability analysis may be said to be concerned with two complementary problems:

1. The reconstruction problem: To what extent is a given system **description** inductively inferable from **descriptions** of **subsystems** deductively inferable from it? (1958, p.6).

(George KLIR, states this point in the following terms: "The aim of the reconstruction problem... is to determine the smallest possible **subsystems** by which a given overall system can be adequately represented) (1990, p.33).

2. The identification problem: To what extent do the **descriptions** of a given collection of systems determine (deductively) the **description** of a single system of which they are each **subsystems**".

"While recognizing what is now commonplace in science, i.e. that "the **whole** is *greater* than the sum of its **parts**" i.e. that it is (usually) not possible to infer from detailed **knowledge** of **subsystems** similarly detailed **knowledge** of a system of which they are **parts**, practitioners of R.A. seek **decompositions** of systems into **subsystems** such that as great a **simplification** as possible is achieved while keeping the loss of **information** regarding the original system within acceptable **limits**". Hence the characterization by CONANT (1988) of R.A. as "a form of enlightened **reductionism**" (1958, p.6).

Says KLIR: "In general the term "system" is used in R.A. for a **set** of **variables** together with some characterization of the **constraints** among these **variables**. Each **variable** of a system is viewed as an **abstraction** of some real-world **attribute**. It is associated with a finite **set** of **states** (**values**) each of which represents a class of appearances of the corresponding **attribute**" (1990, p.34).

These **values** or "**states**" must be measured.

KLIR adds: "In all these measures, the amount of **information** is measured in terms of the amount of reduced **uncertainty**. The more our total ignorance (full **uncertainty**) regarding **states** of relevant **variables** is reduced by the given system, the more **information** the system contains."

"... A discovery that a system can be represented by a specific **set** of **subsystems** may provide the investigator with some **knowledge** that is not available, at least explicitly, in the corresponding overall system. For example, the **subsystem configurations** may give him in-

formation about causal **relationships**, the significance of the individual **variables**, the strength of dependencies among them, etc..." (p.35).

One could add that the **whole** is not only greater than the sum of its **parts**, but is *something else*, in some sense, more than the **parts** and in another sense less than their sum.

The totality masks many specific characters of the **parts**, some of whom may –or may not – be significant for the **whole**. One may surmise that the significant ones are those which intervenes in the **interrelations** among the **parts**.

However, up to some point, these **interrelations** remain occult when we look only at the global integrated system.

Thus, discovering them seems to be the mainpoint of R.A. Moreover they can be discovered only through their **action**, which can be measured through the varying **states** of the **subsystems** or **parts**, interconnected in specific and exclusive ways.

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RECONSTRUCTABILITY ANALYSIS (Basic simplification Principle in)²⁾

"A sound **simplification** of a system should minimize the loss of relevant **information** with respect to the required **reduction** of its **complexity**" (1986, p.270).

G. KLIR explains: "As in the **identification** problem, the loss of **information** is measured here by the increase in **uncertainty**. An appropriate measure of **uncertainty** is thus used again as an arbiter. Among all comparable simplifications of the given system, we accept only these with minimum **uncertainty**. For **probabilistic systems**, for example, the simplification principle becomes the well established "principle of **minimum entropy**" (p.270).

2750

RECONSTRUCTABILITY ANALYSIS (Consistency in)²⁾

A. RAMER and L. LANDER state: "Two systems are called consistent if they induce identical marginal **distributions** of the **set** of **variables** they share. In other words, the **variables** common to both systems are given the same **distribution** by either parent system. An arbitrary family of systems is consistent if its members are pairwise consistent. This condition is often called a hypothesis of local **consistency**, as opposed to a stronger requirement called global **consistency**. Global **consistency** mandates the existence of a hypothetical overall system whose **subsystems** include our family of systems" (1990, p.448).

2751

RECONSTRUCTABILITY ANALYSIS (Identification Problem in)²⁾

G. KLIR writes: "... (this problem) is concerned with a given **structure system** where **elements** are viewed as **subsystems** of an unknown crucial system. The aim is to make meaningful **inferences** about the overall system from **information** in the **subsystems** and, possibly, some additional background **information**"...

"The identification problem belongs to the general **class** of problems of reasoning under incomplete **information**. This type of reasoning is fundamentally different from deductive reasoning in the sense that conclusions are not entailed in the given premises: it is often referred as "**ampliative reasoning**" (1986, p.268).

"In general ampliative **inferences** are not precise. In the identification problem, one can determine only a **class** of overall systems that are implied by the **information** in the given **subsystems**" (ibid.).

2752

RECONSTRUCTABILITY ANALYSIS (Inconsistencies in)²⁾

G. KLIR states: "Two kinds of inconsistency in **structure** are distinguished in R.A.: Local and global inconsistencies. Local inconsistency pertains only to **variables** that are shared by two or more **elements** of the given **structure system**. Any two **elements** that share some **variables** are *locally inconsistent* if their characterizations of the shared **variables** are not exactly the same. A **structure system** is *globally inconsistent* if all **parts** of its **elements** are locally consistent and, yet, the reconstruction family is empty.

"Local inconsistencies are usually caused by the fact that the individual **elements** of a **structure system** are not perfect **models** of **reality**. They are developed from or validated by different **data sets**, each of which is incomplete, imprecise, or otherwise imperfect in some specific sense peculiar to it. Hence, local inconsistencies are a result of our ignorance regarding the **subsystems** involved and, consequently, it is meaningful to try to resolve them by a suitable **method**. At this time, however, research in this area is still in its infancy.

"Local as well as global inconsistencies can also be treated by rejecting the **information** that creates them." (1986, p.269)

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RECONSTRUCTABILITY ANALYSIS (Problems in)²⁾

A. RAMER and L. LANDER describe the following problems, met in reconstructability analysis:

"Approximation problem

If the reconstructed system is different from the original one (and... this is almost invariably the case), how close can we come to that original system?

"Complexity problem"

Exhaustive search through the spaces of possible reconstructions exhibit hyper-exponential **complexity** and therefore are numerically intractable. There is therefore a need for **heuristics** that may guide the search and thus limit its **complexity**. The questions dealing with existence, characterization and applicability of **methods** that may obviate the necessity of a complete search can be described as the **complexity issue**

"Consistency problem (Local)"

Structure systems encountered in practice often exhibit a lack of **consistency** in that the marginal **distributions**, derived from the various **parts** of the system, do not quite agree. This inconsistency is called local, and we would often like to consider it as a minor one. Can it somehow be tolerated and can we still arrive at a reasonable reconstruction?

"Consistency problem (Global)"

Given an arbitrary, locally consistent family of systems, can we determine whether they admit a reconstruction and are thus globally consistent?

"Labeling problem"

Can a family of simple variables be selected to form a system of distinct representatives for the **elements** of a given **structure system**? Here we have actually two distinct problems. One is the very question of existence of such a system of representatives, and the other concerns the usefulness and **meaning** of such a selection... In reconstructability theory we view them as the labeling systems for the general **structure**

"Proximity problem"

What numerical measures are suitable for determining the proximity of two reconstructions? Is any one such measure superior to another? Can such measures be considered metrics or **norms** on appropriate space of reconstruction?

"Reconstruction family problem"

The determination of all admissible overall systems which agree with a given structure system

"Recovery problem"

Given a **structure system**, which originated from an overall system, how can that system be rebuilt, or even an overall system that would agree with our **structure system**?

"Solution problem"

Given only a consistent family of systems (thus a **structure system**), how can we identify, among all the candidate reconstructions, the optimal one?" (1990, p.449-50)

This all sounds quite esoteric. A case example could be very useful.

2754

RECONSTRUCTABILITY ANALYSIS (Procedures in)²⁾

According to R.E. CAVALLLO and G.J. KLIR, three kinds of procedures should be used in Reconstructability Analysis:

"1) Procedures for generating, in an orderly fashion, all desirable **structure** hypotheses;

"2) Procedures for **evaluation** and comparing the general **structure** hypotheses;

"3) Procedures through which it can be decided, at every stage of the reconstructability analysis, which of the generated and evaluated **structure** hypotheses should be used as a basis for further analysis" (1979, p.163).

2755

RECONSTRUCTABILITY ANALYSIS (Systems Concepts in)²⁾

G. KLIR proposes the following definitions for use in Reconstructability Analysis:

"- **Subsystem**: a system based on a **subset** of **variables** of another system.

"- **Structure system**: a collection of systems considered as a unity.

"- **Overall system**: a system that consist of all **variables** in a **structure system**.

"Individual systems of a **structure system**, which are often called its **elements**, may share some **variables**. **Elements** of a **structure system** are coupled through the shared **variables** and, consequently, interact with each other. By definition, each **element** of a **structure system** is obviously a **subsystem** of the corresponding overall system" (1986, p.268).

2756

RECONSTRUCTION FAMILY²⁾

"A class of overall systems that are implied by the **information** in the given **subsystem**" (1986, p.268).

Klir states: "The **size** of the **class**... reflects the inadequacy of the **subsystem representation** of the overall system. The true overall system is always a member of the reconstruction family, but the **subsystem information** is not sufficient (except for special cases) to identify it uniquely. Hence, **inferences** one can make about the overall system from given **subsystems** are inherently imprecise.

"The determination of the reconstruction family is basically a matter of formulating and solving appropriate algebraic equations. These equations characterize, *within the mathematical formalism employed*, the **rules** of projecting the unknown overall system (e.g. overall **state**, or **state** probability) to the corresponding entities of the given **subsystems**. In addition, the *equations are always constrained by the requirements of the mathematical apparatus employed*" (p.269).

In other words, no formalism is neutral, nor is the decision to use it.

KLIR adds: "When the reconstruction family constrains only one system, the identification of the overall system is perfect. In these cases, which are rather rare, the ampliative reasoning becomes deductive reasoning. It may also happen, of course, that the reconstruction family is empty. This means that the given **structure system** is inconsistent" (p.269).

2757

RECONSTRUCTION PRINCIPLE^{2) - 3)}

Reconstructability analysis can be used to produce correct overall **states** that are not contained in the **data** (Adapted from G. KLIR, 1990, p.60).

KLIR comments: "It is important to realize that the reconstruction principle is methodologically different from the usual conception of **inductive** reasoning. The latter is almost exclusively conceived in terms of the so called "straight **rule**", which is well expressed by the following precept offered by RESCHER (1980, p.100):

"When a certain percentage of **population P** have in fact be observed to have a particular trait **T**, then adapt *this very value* as your answer to the question "What proportion of the entire **population P** have the trait **T**?"

"The reconstruction principle violates the straight **rule** since it modifies, in general, the **frequencies** of **states** obtained from given **data** and may produce additional **states** that are not contained in the **data** at all".

"How to explain the reconstruction principle? First, let us recall that the principle is based on the identification of **subsets** of **variables** of the overall system that are strongly related. These **subsets** of **variables** are expressed by the superior reconstruction **method**" (KLIR, 1990, p.75).

RESCHER's concept of **induction** must be based essentially in statistical or experimental **inquiry** used as **reductor** of **variety**.

On the contrary, R.A. introduces "superior hypotheses" and is open to wide exploration of the preselected **data** related to specific **parts** or **subsystems**.

2758

RECONSTRUCTION PROBLEM²⁾

G. KLIR states: "This problem is concerned with the question of how a given **generative system**, assumed to be employed in **modeling** some aspect of reality, can be broken down into appropriate **subsystems**. A collection of **subsystems**, which in our terminology is a **structure system**, is appropriate when it is sufficient for reconstructing the original overall system to an acceptable degree of approximation".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"Two preference orderings are essential for comparing competing **structure systems** in the reconstruction problem. One is expressed in terms of the amount of **information** that is lost when the overall system is replaced by a **structure system**. Let this preference be called *information ordering*...

"The second preference ordering involved in the reconstruction problem is connected with the size of **subsystems** contained in the **structure system**: smaller **subsystems** are preferred. This latter preference ordering may be called a **complexity** ordering since a reduction in the size of a system tends to reduce the size of its **description**. It is only a partial ordering" (1991, p.106-7).

As to the practical aspect, KLIR states: "Both the reconstruction and identification problem are computationally very hard. As a consequence, the applicability of reconstructability analysis has been limited to systems with a modest number of **variables**, say a dozen or less. Recent developments of some powerful **heuristic** procedures by Roger CONANT seem to indicate, however, that systems with hundreds and possibly, even thousands of **variables** could be analyzed on existing large computers" (p.348).

2759

RECRUITMENT^{1) - 4)}

The addition of new **elements** or replacement of lost ones in a system by **elements** obtained from another one.

Recruitment takes place either when a system has been severely reduced by some **disturbance** (an ecosystem after a hurricane f. ex.), or when it is growing (a country accepting immigrants). The new **elements** need be compatible with the system, while not necessarily similar to any former or still existing ones, in order to avoid **rejection** or subsequent internal **disorder**.

In **ecosystems** according to S. REICE: "Recruitment has a major impact on the outcome of **competition** and, consequently, on **community structure**. This idea, dubbed supply-side **ecology** by R. LEWIN, asserts that physical transport **processes** are important determinants of **community structure** because they set the supply of colonists to habitat **patch-work**" (1994, p.432).

Recruitment is at least in part a **random process**, as the **identity** of the new **elements** is never perfectly defined. It may as well deeply modify the **identity** of the recruiting system. S. REICE states: "Stochastic (**random**) recruitment in a **heterogeneously** disturbed, patchy **environment** results in high overall species **diversity**" (p.427).

2760

RECURRENCE THEOREM²⁾

A **dynamic system** will go back arbitrarily close to its initial **state**.

This theorem was introduced by H. POINCARÉ and is, in fact, historically the first theorem related to **ergodic systems**. It is to be noted that POINCARÉ's theorem says nothing about the **time span** needed to observe the return to the initial **state**: in very **complex** (and **chaotic**) **systems**, it can become so long as to lead to a practical impossibility.

2761

RECURSION¹⁾

A **mechanism** of circular **self-reproduction** of **components** and/or **relationships** in a system.

Or: The cyclical creation or recreation of **elements** or **interrelations** in a system through the application to existing **elements** or **interrelations** of a specified **feedback** or **set of feedbacks**.

The **feedbacks** are specified within the system from its very **autogenesis** on, through **organizational closure**, of which recursion is practically the signature.

An example is **fractal branching**.

Recursion can in principle be applied on its own results without **limits**.

F. FRISCHKNECHT and J.P.van GIGCH observe: "Recursion is a finite prescription of an infinite **process**" (1989, p.243), and: "**Nonlinear feedback** (i.e. recursion) is the novelty that burst into physics challenging its old axiomatic **models**. Recursion replaced mathematical axiomatization by **constructivism**, **state** by **process**, **models** by **metamodels**" (p.249). The same authors state the very important conclusion that these **metamodels** "... only furnish second-order **knowledge**, they do not predict, they just simulate. This is the only way to understand **complexity**: to know its **rules**, the **states** being unpredictable" (Ibid).

"Unpredictable" should be possibly better replaced by "only imprecisely predictable", as **chaotic randomness** is still basically **deterministic**.

Recursion is an essential feature of the **autopoiesis theory**. **Organizational closure**, i.e. the permanent self-reconstruction by a system is entirely dependent on recursion. This is seemingly also true in the psychology of identity, in psycho-pathology and in social and cultural systems.

Recursion seems to operate only within **networks** (which necessarily possess **rules** of **self-organization** and **self-reproduction**).

A formal calculus of recursive **self-reference** has been developed by G. SPENCER BROWN (1969) and extended by F. VARELA (1975).

2762

RECURSION (Level of)^{1) - 4)}

"A level at which a **viable system** is in operation, as an **autonomous part** of a **higher-level viable system**, and containing within itself **parts** which are themselves **autonomous viable systems**" (St. BEER, 1974, p.72).

This definition is applicable to all **viable complex systems**, including **social systems**. However, as BEER himself discovered and explained, the problem of modern governments (of any type), is that none has a satisfactory **model** of the real workings of the society it is supposed to "govern", i.e. regulate. This shows ignorance of the basic principle according to which: "No regulator can actually work unless it contains a **model** of whatever is to be regulated" (p.34).

The situation seems to be still worse than this: Governments and politicians apply recursion to their own **beliefs**, or imaginary **model** of the society to be governed. (See "**governability**"): Recursion on figments generates... metafigments.

In a more abstract sense, recursion produces basically "vertical" or **hierarchic structures**, that can be characterized by the prefix "**meta**", as in **metasystem** (van GIGCH), **metacontrol** (van GIGCH), **metalanguage**, **metamodel** (van GIGCH).

It is helpful in order to distinguish **logical types** or **levels**, avoid **paradoxes** and avoid confusion in **organizations**.

J.van GIGCH observes: "Levels of recursion do not necessarily carry implications concerning authority or **ethics**, i.e. higher levels of **control** do not have *more* authority or are *better* in the moral sense than lower ones" (1986 b, p.90).

2763

RECURSION (in mathematics)²⁾⁵⁾

The definition of a **function** in terms of itself.

2764

RECURSIVE EQUATION²⁾

An iterative equation in which the results of each step of calculation are reintroduced in the following step.

In many cases, such an equation is computer processed and the seventeenth decimal in the successive results is neglected. While the iterative **process** is **deterministic**, the neglect of successive seventeenth decimals leads to a progressively growing **unpredictability** and introduces **chaos**.

2765

RECURSIVITY or "recursiveness"^{1) - 2)}

"The application of a **function** to its own value to generate a series of similar values" (JOHANSEN BERTOGLIO - 1985).

Recursivity is a constructive **process**, not merely a structural **embedment** feature, as would be for example a set of wood carved Russian dolls.

The mathematical concept has been transferred into the **autopoiesis theory** and experimentally explored by M. EIGEN et al (1975, 1979 and 1992).

A. ZELENIKAR comments on recursivity in the following way: "**Processes** in an **autopoietic** system are organized circularly, as they depend recursively on each other; they form a recursive **closure**. Production **processes** are synthesizing, transforming or destroying various **components** which appear in an **autopoietic system**. For instance, destruction of **components** produces substrate on which **processes** of production can act. A unity assembles its **components**" (1988, p.208).

According to F. BAILLY, F. GAILL and R. MUS-SERI: "Recursivity corresponds to a principle of **information** economy by the use of one and only one reiterated formal law for each stage of **development**. Such a simplicity is perfectly compatible with a very rich combinatory and morphological power and its intrinsic uniqueness harmonizes well with the **representation** of an integrated and determined individuality" (1991, p.58).

Recursivity is also a **crosslevel process**, in which case it may be **self-similar** in a **fractal** sense. **Reproduction** of the **elements** (or **sub-systems**) and their characteristic **interrelations** is a **global process**, which operates, for example:

- in a living being, by the multiple action of its genetic **code**;
- in a society, by way of a **set of values**, norms and **knowledge**, transmitted through **processes** of education and instruction.

Recursivity makes the system's **behavior** *more or less* predictable, because it implies a limited (while sometimes gigantic) **repertoire** of possible **states**, given in sequences acceptable for the system.

Moreover, from **level to level**, some measure of **self-similarity** can be observed. **Organizational closure** is a **crosslevel isomorphy**.

In reference to human systems, J. JOHAN-NESEN makes an interesting comment: "At every **level** of recursivity, there will be two conflicting tendencies:

1. The tendency to function as **part** of the larger system
2. The tendency to maintain individual **autonomy**" (1991, p.44-5).

Thus, recursivity seems to be a result of a peculiar class of individual response to **interactions** (Those which are – or seem – useful to the **components**) and of a **constraint** favoring systemic **cyclical** or **catalytic self-reproductive processes**, through a kind of reciprocal conditioning. This could well emerge as a basic law of **sociogenesis**.

As observed by J.C. LUGAN, "The idea of recursivity breaks off from the **cause-effect linear concept**... It introduces a self-constitutive, self-producing and self-organizing **cycle**" (1993, p.92).

A similar opinion is G. BATESON's who considered **cybernetics** as "dealing with problems of **control**, recursiveness and **information**" (1979, p.227)

2766

RECYCLING ¹⁾

"Converting ... **wastes** into new products by using the **resources** contained in them" (adapted from the UNESCO – UNEP glossary of environmental education terms).

Nature recycles automatically all of its productions, even if this **process** sometimes covers eons. This is not the case for many human products which artificial character does not allow for their insertion in natural **cycles**, or because **accumulation** of **waste** is too fast to be accommodated by natural **processes**.

Recycling is a typical systemic theme. It covers practically all the products of human activity, and not only "solid" **wastes** as stated by the UNESCO – UNEP glossary.

Indeed, every product terminally becomes **waste** in the long run. And gases, liquid effluents and most of all, heat resulting from **entropy** production should be considered.

The systemic problem is to put the use of natural **resources** and **energy** as much as possible in a recurrent **circuit**. This aim implies scientific and technical research, economic rethinking and a change in socio-cultural **values** and subsequent management politics.

→ **Economics in systemic terms; World engine**

2767

RED QUEEN EVOLUTIVE PARABLE ^{1) – 3)}

L. CARROLL 's Red Queen parable in "Alice in Wonderland" alludes to the need to run evermore swiftly in order to be able to stay in the same place.

This strange **metaphor** now becomes a parable about competing **co-evolution** of species (or **organizations**). A favorable **adaptation** in one – for example, a predator – may bring negative results to the other, the prey. This orients the **evolutionary adaptation** of the latter in such a way to counteract the negative **effect**. After much "running", both species find themselves in the same relation.

D. HILLIS has now modeled this **process** on his **connection machine**, showing that this is a general **model** for countervailing evolutionary **processes**.

2768

REDUCIBILITY ²⁾³⁾

The many-times hypothetical presumption that a complex problem can be reduced to a host of solvable more simple ones.

See however "**Compressibility**"; "**Variety reduction**"

2769

REDUCIBILITY (Non-) ¹⁾²⁾

Non-reducibility is a typical property of **autopoietic systems**, which, by definition, must be **recursive**.

This means that the system cannot be much simplified, by suppressing **elements** and/or not considering recurrent reconstructive **interactions**, mostly multiple and **simultaneous**. Doing this could decisively alter it, or even destroy it.

→ **Eigen-; Eigen-value; Reducibility**

2770

REDUCTION (Emergence and)

→ **Emergence and Reduction**

2771

REDUCTIONISM ^{1) – 3)}

1. "A descriptive and investigative **strategy** which gives account of **phenomena** in terms of a series of isolated **parts**, coupled together by direct causal **linkages**" (T.F.H. ALLEN & T.B. STARR, 1, p.276).

2a. A principle "according (to which) all scientific concepts are reducible to a **set** of ultimately irreducible concepts" (R.L. ACKOFF, 1974, p.53).

2b. "The belief that everything in the world and every experience of it can be reduced, decomposed, or dissembled to ultimately simple **elements**, indivisible **parts**" (R.L. ACKOFF, 1991, p.325).

3. The claim "that properties of a **whole** are explicable in terms of properties of the constituent **elements**" (G. KLIR, 1991, p.24).

4. "... the task to find the simplest, most economical and (usually) most elegant **explanation** that will cover the known **data**" (G. BATESON, 1979, p.230).

T.F.H. ALLEN and T.B. STARR add: "**Ambiguity** in **relationship** between **parts** is met with further subdivision until the **ambiguity** disappears" (ibid).

As a result "Reductionism is thus the strongest possible way of ordering the list of the various sciences" (I.I. MITROFF and H.A. LINSTONE, 1993, p.165).

Commenting his definition, ACKOFF states that these "ultimate concepts", according to some "were provided by direct **observation**" and to others "thought of as undefined con-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

cepts of a formal system". And, "Whatever their source, these concepts were identified as "physical thing predicates"; that is, physical properties of things".

BATESON adds to his definition the following caveat: "Beyond this, reductionism becomes a vice if it is accompanied by an overly strong insistence that the simplest **explanation** is the only **explanation**. The **data** may have to be understood within some larger **gestalt**" (Ibid).

For a good example, see: **Selection (Multi-level)**

Reductionism is a **paradigm**. R. ROSEN expresses this as follows: "The belief that any natural system can be so decomposed (note: i.e. extensively, and possibly limitlessly), and that the laws governing the motions of these particles can be determined, is the essence of reductionism" (1979, p.174). The "belief" is something like the hardening of an **assumption**.

The conceptual origins of reductionism are to be found in DESCARTES and NEWTON, if we are not going back in time to DEMOCRITUS, EPICURUS and LUCRETIUS.

The basic (and largely unconscious) tenets of reductionism seem to be the following:

- what should be researched are the properties of **objects**, which are "real" and perfectly knowledgeable
- the **observer** or experimenter is "transparent", i.e., without influence on the perceived **objects**
- the "**et ceteris paribus**" postulate can be applied without restrictions, which allows for **linear causal** explanations
- supposedly, no significant aspects of **phenomena** are thus left out, (forgetting for example **interrelations** between **elements** or **parts**, or between **levels**)
- larger **contexts** do not influence upon **phenomena**

Systems concepts are however not *opposed* to the reductionist approach, as they admit **levels of description**. This point was made as follows by P. WEISS (quoted by G. KLIR, 1991, p.26), who describes a neutral stand: "The reductionist likes to move from the **top down**, gaining precision of **information** about fragments as he descends, but losing **information content** about the larger orders he leaves behind: The other proceeds in the opposite direction, from below, trying to retrieve the lost **information content** by **reconstruction**, but recognizes that that **information** is not forthcoming unless he already had it on record in the first place. The difference between the two **processes**, (is) determined partly by personal predilection, but largely also by historical tradition".

This does not make clear that the main concern of the systemist are the **interactions** within the same **level** as well as between different **levels of complexity**, in the **whole**.

Moreover, as stated by I. PRIGOGINE (quoted by F. David PEAT, 1987, p.64), "... there is no "fundamental **level**" in nature but rather each **level** involves its unique **description** and is conditioned by the **levels** around it".

In some sense, reductionism is thus "inscribed" within the systemic approach as: "Nature... requires pluralistic **descriptions** and ... this pluralism must contain both **causal** and **synchronistic** aspects" (Ibid).

In an overview of this subject, J.A. GOGUEN and F.J. VARELA conclude: "Reductionism implies attention to a lower **level**, while **holism** implies attention to a higher **level**. They are intertwined in any satisfactory **description**; and each entails some loss relative to our cognitive preferences, as well as some gain" (1979, p.42).

Reductionism may also be understood as the use of OCKAM's razor, as stated by P. CHECKLAND, who writes: "And we use reductionism in another sense in explanation, explaining the results using the smallest number possible number of concepts, only importing more elaborate concepts when defeated in this" (1976, p.128).

Still another meaning frequently given to reductionism is the stand according to which social and biological sciences can ultimately be reduced to explanations based on physical sciences. While anything social or biological is by necessity based on physical properties, the reductionist stand ignores the existence of successive **levels of complexity** grounded on the **emergence of dissipative structures and synergies**.

On this topic D. CAMPBELL accepts: "... the limited **emergentist** principle that laws of biology, psychology and sociology exist which are not described by the laws of physics and inorganic chemistry. These **emergent** laws are compatible with the laws of physics and chemistry but not derivable from them" (1975, p.1104).

At long last, the fundamental difficulty becomes obvious: so-called laws must be non-contradictory between them to be acceptable on all **levels**. The best example has been the elimination of the vitalist stand in biology when the apparent impossibility of life in terms of classical **thermodynamics** was taken care of successively by such **models** as **open system**, **homeostasis** and finally **dissipative structuration**. It should be noted that none of these **models** are "laws", nor their applications limited to any particular scientific discipline.

P.M. ALLEN et al. observe that "the very success of reductionist science has... provided man with the power to radically change his **environment**. However, this science has afforded almost no **knowledge** of the probable **effects** of such **actions** in the **complex systems** en-

countered in the domains of biology, ecology and socio-economics. **Policy** today must be formulated in a world of ever increasing **interaction and complexity**" (1984, p.2).

2772

REDUCTIONISM AND CAUSALITY^{1) - 3)}

In his critique of the second and the third precept of DESCARTES "**Discourse on the method**", J.L. LE MOIGNE states: "Reductionism implies somehow **causality** and conversely" (1990a, p.19).

While DESCARTES suggested in his third precept to start "with **objects** the simplest and easiest to know" and "ascend by little and little, and, as it were, step by step, to the **knowledge** of the more complex" (1947, p.175), he did not explain *how to do this*.

He did not seem to be aware that the application of his second precept *destroys* these composed **objects** because their breakdown in simple **objects**, as he recommends, eliminates their numerous internal relations, keeping only some privileged one.

Moreover, it becomes less and less obvious, for example in physics with the case of the quarks, that "smaller" is also "simpler and easiest to know".

2773

REDUNDANCY¹⁾

1. Repetition of **elements** in a **message** or system which permits to circumvent **transmission errors** or functional failures.

2. A measure of how much **knowledge** about **parts** of the system allows to know something about other **parts**, due to known **constraints** between them (H. ATLAN, 1989)

3. "...the number and **variety** of internal **subsystems** which can perform the same **function** equally well" (W.D. GROSSMANN & K.E.F. WATT, 1992, p.10).

In relation to the first definition, it should be noted, in M. MARUYAMA's words that: "If a **message** can be **compressed** shorter by an efficient **coding**, then the amount of space saved by the **compression** is called redundancy" (1992, p.196).

This is the original **meaning** given to the term by C. SHANNON in his theory of **communication**. Redundancy here is used to compensate **noise** and to maintain **reliability** in the **communication process**. K. KRIPPENDORFF states: "English writing is estimated to be 50% redundant which account for the ability of native speakers to detect and correct typing errors" (1986, p.64). Redundancy is also useful for reconstruction of mutilated **messages**.

As to W.D. GROSSMANN and K.E.F. WATT they state: "Redundancy... provides **reserves**" (ibid., p.8). In this case, failure of one **circuit** or **channel** can be compensated and reliable systems constructed from somewhat unreliable **parts** (von Neumann).

If redundancy, in ATLAN's opinion, reflects **constraints**, or the **organization** of the system, it is however obvious that an excessively redundant system (i.e. very **constrained** one) cannot have much functional **meaning** and, if totally redundant, none at all.

This is why "one finds also **variety** or **diversity** as a property typical of the existence of an **organization**, especially when **complex adaptive behavior** is exhibited. This property is in fact opposed to the first one (i.e. redundancy) and it is a measure of the **uncertainty** or unexpectedness of the so-called **information content** of a system, in the formalism of **information theory**. As such it can be used to measure the **complexity** of a natural **organization**" (1989).

Thus, any **complex system** needs simultaneously **variety** and redundancy, which are in some sense complementary.

When the system ages, its redundancy diminishes, while its **variety** grows, up to a limit which is a characteristic of the system. The construction of **variety** uses up redundancy.

2774

REDUNDANCY in NETWORKS ²⁾

The existence of a multiplicity of **nodes** and **paths** between them, able to perform in an equivalent manner.

The theory of redundancy in networks was developed by W.S. McCULLOCH, W.H. PITTS and J.von NEUMANN, who showed that redundancy offered the only hope to obtain satisfactory operative results from networks made of sometimes unreliable **components**.

In St. BEER words: "...von NEUMANN propounded a mathematical theorem which showed that if one is prepared to go on increasing the redundancy of a network without **limit**, it is possible to obtain an **output** of arbitrarily high accuracy from a network whose **components** are of arbitrarily low **reliability**" (1968, p.201).

This is so in natural networks, like the cerebral cortex, which remains more or less reliable as a **whole**, even when numerous neurons have been lost, for example because of a cerebral haemorrhage. It is also the case in artificial networks and even in social ones, as may be seen when they repair themselves, sometimes after massive destruction of **elements** and **interconnections**.

2775

REDUNDANCY (Knowledge implicit in) ³⁾

O.S. AKHMANOVA states: "The redundancy of a text is a consequence of the fact that the different **elements** – words, and also **parts** of words, letters are not independent from each other. There are probabilistic **connections** between these **elements**, determined by the probabilistic **structure** of the **language**. It is just the **knowledge** (possibly unconscious) of this **structure** that allows us to fill in the abbreviations of the text" (1960, p.199).

"Probabilistic" should be understood as "defining more or less probable **connections**, in accordance with the specific **constraints** that characterizes the **language** used".

Such **constraints** per se are precisely "anti-probabilistic" and our **knowledge** of them is what allows us a significant "reading" of any text, even *more or less* pruned of its redundancies, by guessing "what should come now".

Of course, redundancy exists only when there is a **meta-knowledge**. Who does not know Japanese cannot perceive any redundancy in a **message** in Japanese, even if it is perfectly present therein.

2776

REDUNDANCY of POTENTIAL COMMAND ¹⁾

St. BEER states: "This subtle feature of effective **organization** was (thus)... named by the distinguished American cybernetician Warren McCULLOCH" (1968, p.457).

BEER explains it in the following way: "... it is the possession of **information**, rather than bestowed authority, that confers the right to act. So in any **network** of **channels** and **nodes**, some **sub-system** of the total system acquires a commanding state of **knowledge** at a given epoch of **time**... In a completely established **hierarchy**, it is known in advance what **sub-systems** work as **entities**, and which of them command what aspects of **control**. But in a **self-organizing** system, or in a system designed for **learning**, **adaptation** and **evolution**, it is necessary for alternative groupings to be possible. So the third form of **redundancy** lies in the potential for **command**: it is a **behavioral**, not a **structural component** of the system" (ibid).

The potential for **command** is, in last resort, the potential for creating new relevant organizing or regulating **interrelations**.

BEER emphasizes that: "The trick was learnt from the **brain**, once and again, and may readily be observed in operation in any social group" (ibid).

This is the most general explanation of the sudden appearance of organizing centers or new leaders in developing systems. It will probably also be the final basic condition of self-organizing **artificial intelligent** systems.

2777

REDUNDANCY (Spreading of) ¹⁾

G. BATESON states that redundancy is not only something perceived and helpful to the receiver of a **message**.

"In a wider universe, i.e., that defined by the point of view of the **observer**, this no longer appears as a '**transmission**' of **information** but rather as a spreading of redundancy... The activities of A (the **sender**) and B (the **receiver**) have combined to make the **universe** of the **observer** more predictable, more ordered and more redundant" (1973, p. 383).

There is however again a condition: The **observer** must know A and B's codes.

2778

REFERENCE CONDITION ¹⁾

The reference conditions of a system is a synthesis based on sets of reference **signals** relative to different aspects of the system's **behavior**.

W.T. POWERS who introduces this notion gives the example of a driver in a car, who is concerned **simultaneously** with **signals** related to the present state of the vehicle; to the state of the road, to the position of other moving objects; to the conditions of the weather, etc...

And all this is observational, i.e. depending on the physiological empowerment of the driver, that includes correct **perceptions**, synthetic capacity of the **brain** and good **performance** of the nervous and muscular **subsystems**.

(Adapted from the author's page on the web)

→ **Reference frame**

2779

REFERENCE ENTITY

→ **Stigmergy**

2780

REFERENCE (External) ²⁾

N. LUHMANN writes: "The difference between **subject** and **object** (thinking and being, **knowledge** and object) is nothing else but the distinction between self-reference and external reference" (1995, p. 8)

The autopoietic system connects itself with some external reference through **structural coupling**, i.e. "external" becomes "reference" only when the system reacts to some feature in its **environment** and, in some way, internalizes the "external".

2781

REFERENCE FRAME ³⁾

The coordinated **set** of **relations** between **elements**, usable for the comprehensive **representation** of more numerous or extended **elements** of **knowledge**.

The progressive construction of reference frames is a significant part of any **learning process**, be it in natural or in **artificial intelligent systems** (see "**connection machine**").

The Spanish neurologist J.M.R. DELGADO observes that: "Skills are not unveiled, because they do not preexist. Their neural mechanisms, including the frames of reference, must be constructed within the **brain**. Motor coordination and skillful performance do not emerge from the **brain**, but must be absorbed by it through the experiences and **information** provided by sensory **inputs**" (1993, p.302).

Reference frames are a result of specific **constraints** which result, and later on, lead to **rewards** considered positive and to the construction of interpretation **codes**, i.e. more **constraints**. However, once established, reference frames become **autopoietic**, by some **self-replication process**, not yet very clearly understood.

Writings, **semantic** and grammatical **rules**, scientific theories, religious **symbols**, and **ideologies** are reference frames (irrespective to our **evaluation** of the same).

They are kinds of open **algorithms**: they do not allow to discover some interpretation for something that they do not contain at least in an implicit form, but they permit nevertheless an enormous combinatory wealth.

They build up by **constraints** on the initial potential **variety** of the system (See "**order from noise**") and act as global **transducers**.

G. PASK states: "Although the reference frame depends upon the **observer**, his choice is conditioned by all his previous experience and by convention" (1961a, p. 121).

As noted by PASK, in science, the consensual selection of reference frames allows for comparable **measurements** and communicability of results (Ibid).

From the systemic viewpoint: "The reference frame itself is a system. It satisfies a definition proposed by Colin CHERRY that a system is an 'ensemble of **attributes**'" (Ibid., p.23).

→ **Frame**

2782

REFERENCE FRAME: Time – Space – Form ^{1) – 3)}

According to J.L.LE MOIGNE: "The modeling power of the **process** concept is a result of the surprising simplicity of the **transformations** types: when an **object** (or a family of **objects**) is processed and identified, its processing will always be framed without **ambiguity** inside of a permanent **triadic reference frame**. To act or interfere upon a given **object** is to affect its position in **time** (always), in **space**, frequently (by transportation or **transmission**), and/or its **form** or **morphology** (**transformation**) Doing, acting intervening, functioning,

changing or whatever, is in every case affecting the position of at least one **object** in a reference frame T.S.F.: i.e. Time, Space, Form" (1990a).

It seems useful to add that such a reference frame can exist only thanks to some form of **energy** which generates **transformations** of all types. One is indeed carried back to the basic group of irreducible concepts used within this dictionary: **Energy, Time, Space and Matter**.

Should one admit that information is a modulation of **energy**, nothing can seemingly escape from the T.S.F. **reference frame** or some equivalent one. Moreover, any **object** or system can thus be identified at any instant without any **ambiguity** or possible superposition within the **reference frame**.

2783

REFERENCE FRAMES (Evolving) ¹⁾⁴⁾

Reference frames-whether individual or socially more or less shared- are basically adaptive mental and behavioral devices, corresponding to specific **situations**.

However, **fitness** is not forever, precisely because situations do change. Any reference frame needs thus more or less frequent updating: it must be not only adapted, but also adaptive.

As observed for example by Th. KUHN in the case of scientific **paradigms**, such **changes** can be slow, difficult and even painful (in cases, they imply even impossible mental and/or behavioral shifts for some people)

This necessity for change can lead either to dramatic **discontinuities** (mental troubles, revolutions), or to more or less peaceful **transitions** through psychological change in **autopoietic** ways or shifting **consensus** among people through **conversation**.

The present transition toward the "**man-planet**" **system** through so-called **globalization** would be possible without tragedies only through a deep evolutive reconstruction of individual and shared reference frames worldwide, even if this is obviously a tall order.

→ **Adaptability (or Adaptiveness); Consensus; Conversation; Framing; Learning (Systemic); Purpose in social systems; Social cybernetics; System (Self-modifying)**

2784

REFERENCE FRAMES (Shared) ¹⁾⁴⁾

Every individual constructs his/her personal reference frame and none is perfectly identical to any other.

However they may be more or less similar and they need to be for any social life to become possible.

In fact, people engaged in similar **activities** (engineers for instance) share a technical reference frame in their specific activity, even if each engineer is working in his own slightly different way. Engineers are thus able to understand each other in their field, and also to develop similar habits and a specific **behavior** in their society.

In a wider sense, members of the same **culture** identify themselves through shared **beliefs** and common **understandings**: religious, linguistic, philosophical and behavioral.

While reference frames as extended to **communities** are a convenient **abstraction**, they correspond anyhow to common mental and psychical orientations, whose effects may lead to a **group coordination** and even "bring people in line" in the sense of the German word "Gleichschaltung"

→ **Cohesion; Consensus; Conversation; Groupthink; Social system (Human); Sociality; Socialization**

2785

REFERENCE STRUCTURE

→ **Stigmergy**

2786

REFERENCE VALUE ²⁾

The set-point or **standard** to which a **regulator** compares the observed values.

By comparing the observed values with the standard, the **regulator** produces an error's measure that is used to define a correction to be imposed by the **effector**.

In accordance with a **memory** (i.e. register) of previous **states**, several reference values may be inscribed within the system.

2787

REFLECTIVE CONVERSATION

→ **Stigmergy**

2788

REFLECTIVE SYSTEMIC PROPERTIES ⁴⁾

"Properties of a socio-cultural or political **system**, as observed on a visible **level**, that reflect **concepts** or **values** rooted in a deeper **level**" (Fuschl Conversations, May 2000 on "Social awareness")

The basic general organized **level** in such a system is the one of **values** and **norms**, explicit or implicit, generally of religious origin. If the explicit **organization** and **behavior** contradict the implicit **values**, the system's **stability** (and in cases, its survival) is at risk.

2789

REFLEX (Conditioned) ⁵⁾

"A reflex **response** which is developed in special **training procedures**" (J. ECCLES, 1977, p. 235)

As well known, the basic research in this subject has been done by I. PAVLOV.

Of course, when the reflex is conditioned, it is still conditional, i.e. the trigger **signal** is always needed and must be given in a precisely recognizable way.

When the reflex is not solicited during a long **period**, it tends to wane, but may generally more or less easily revived.

→ **Habituation; Hebb's rule stimulus**

2790

REFLEX (Functional) ^{4) - 5)}

A reflex is functional if it responds adequately to the **command** triggered by the **stimulus**.

A **behavior** is functional if it is adequately adaptive. The **functional behavior** however, is created at the reflexological (or instrumental) **level** through the ordered inclusion of a number of coordinated reflexes within a reflexological system:

- able to produce a considerable **choice** of different sequences
- integrated, i.e. working as a regulated unit.

ASHBY expresses it in the following way: "the value of one **part's behavior** cannot be judged until the **behavior** of the other **parts** is known; and the values of *their behaviors* cannot be known until the first **part's behavior** is known. All the valuations are thus *conditional*, each depending on the others" (1960, p.7).

2791

REFLEXIBILITY ²⁾³⁾

Norma ROMM connects reflexivity to interdisciplinary practice, in which both **agents** are at the same time participant and **observer** (1998, p.67, as quoted from BAWDEN by Romm)

She also tackles the difference between **interdisciplinarity** and **multidisciplinarity**, which "often amounts to a dialogue of the deaf in which incompatible research approaches are pursued in parallel with little or no **communication** between them : (as quoted from M. JONES in his paper "It all depends what you mean by discipline")

In fact in multidisciplinary meetings, **reflexibility** becomes generally drowned in a confuse and overbearing **noise**.

In a note in her paper N. Romm makes some observations about **transdisciplinarity**, but disclaims any intention to develop this aspect.

This is lamentable because it would seem that **transdisciplinarity** emerges as a set of practices by disciplinary specialists acting among them in a constant reflexive way that leads them to create multi-**cross-** (i.e. trans-) disciplinary **concepts** and **models**.

S.L. PAYNE reworked the subject in a subsequent article, but the differences between interdisciplinarity and transdisciplinarity remain still unstated (1999, p. 173-181). This is quite obvious in the general literature.

→ **Cross disciplinarity; Living systems; Taxonomies of systems**

2792

REFLEXION FROM REFLECTION ³⁾

To have two different spellings for what is considered the same word in many dictionaries comes now to be quite useful. The works of G. PASK, H. MATURANA, F. VARELA and D. SCHÖN, as well as in another style the work of P.P. GRASSÉ have illuminated the **difference** (as well as the **connection**)

Reflection has a psychological **meaning** related to its physical meaning. It takes two, or more, conversants "reflecting" to each other their views, to start a "**conversation**" in which each one is trying to interpret whatever the other is showing or saying him.

This kind of psychological **experience** "with the other" is also the basis of a human **structural coupling** in the way of MATURANA. It leads to a kind of cooperative **autopoiesis** through which each participant comes to accommodate the thus obtained experience through **perception**, into his own self-**understanding**. This is of course "reflexion" and a **recursive process**.

2793

REFLEXIVITY ¹⁾

The potentiality for any **component** of a **complex system** to exert some determinating **action** on any other **component**.

This concept has been introduced by J.W. SUTHERLAND in his "General Systems philosophy for the social and behavioral sciences" (1973, p.39, 99).

SUTHERLAND expresses that reflexivity can be "... so intense that the **part** removed from **context** for analysis becomes a fiction of no ontological (i.e., real) significance" (p.39).

Another important consequence of reflexivity is that, as any **component** may at any moment interact with any other one, the **macro-determinism** of the system is somewhat reduced, and **semi-deterministic chaos** may appear.

2794

REFRAMING ²⁾³⁾

A shift in one's **viewpoint** that allows for different aspects of an **issue** or **theory** to be taken in account.

Reframing has been a characteristic mental and conceptual attitude in **epistemology** and even in specific scientific disciplines all along the 20th century.

It is highly visible in scientists and thinkers as different as MARX, PLANCK, EINSTEIN, BERTALANFFY, BACHELARD, KORZYBSKI, etc., and more recently D. BOHM and M. FOUCAULT and of course H.von FOERSTER and MATURANA and VARELA.

Reframing has also been extensively used by the Merida School of **Interpretive Systemology** in Venezuela for the study of social issues in that country.

Such a mind stretching **strategy** by which the very **methodology** of **inquiry** is expanded in order to avoid multiple contradictions leaves lingering doubts about the nature of human **understanding**, at least as it was firmly and strongly believed to be in classical thinking until at least the end of the 19th century.

→ **Knowledge; Ontological skepticism; Order (Implicate); Reference frame**

2795

REGENERATION ¹⁾

The condition of a **complex system** which recycles or reproduces its different **elements** through an **array** of interconnected and interacting closed **loops**.

M EIGEN and P. SCHUSTER explained this process by developing their **hypercycle concept** (1979).

While regeneration is never perfect, this **periodic recycling process** insures the **dynamic stability** of the system, as long as a certain critical **level** of copying errors is not exceeded.

Ageing and **senescence** seem to be related to the crossing of such a **threshold** by progressive **accumulation** through **time**.

While the regeneration **mechanism** is internal, it is still dependent, as observed by H.T. ODUM, on "... a regenerative complementary **ecosystem**" (1971, p.287) (or **suprasystem**).

2796

REGENERATION CIRCUIT ^{4) - 5)}

J.O. WISDOM in a paper on "The hypothesis of **cybernetics**" debates the concept of "regeneration circuit", derived from the reverberating **circuits**, which, according to certain neurologists (A. FORBES, R. LORENTE de NO), do exist in the **brain** and could be the carriers of **memory**. (1956, p.117-8). Such **circuits** must necessarily be repetitive, or even permanent, in order to allow for their use each time that they are needed. This has been thus expressed by W.S. MC CULLOCH: "... A train of impulses in a regenerative loop preserves the **form** of the fact without reference to the particular moment when it was experienced" (Ibid., p.118).

It must thus be necessarily an intermittent and more or less cyclical or scandened process (hence the term "scansion" proposed by WISDOM).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

It would be interesting to investigate the re-generation **circuits** at the **level** of societies and cultures memories.

2797

REGENERATION CYCLE²⁾

The succession of **states** through which a system returns to its optimal **state** after some **perturbation**.

This concept is basically an ecological one.

It could however be extended to any system and is closely related to the **autopoietic** and **organizational closure model**.

Regeneration cycles are specific to dynamic **equilibrium systems**. It is however somewhat doubtful if any system at all is able to regenerate itself *perfectly*.

→ **Climax**

2798

REGIME¹⁾

A type of more or less regular **behavior** characteristic of a system.

St. KAUFFMAN distinguishes three basic types of regimes: **ordered**, **complex**, or **chaotic**. He states: "In the ordered regime, many **elements** freeze in fixed **states** of **activity**. These **frozen elements** form a large connected **cluster**, or **frozen component**, which spans, or *percolates*, across the system and leaves behind isolated islands of unfrozen **elements** whose **activities** fluctuate in complex ways. In the **chaotic** regime, there is no frozen **component**... In this chaotic regime, small **changes** in **initial conditions** unleash **avalanches** of **changes** which propagate to many other unfrozen **elements**. These **avalanches** demonstrate that, in the **chaotic** regime, the **dynamics** are very sensitive to **initial conditions**. The **transition** from the ordered regime to the **chaotic** regime constitutes a **phase transition**, which occurs as a **variety** of **parameters** are changed" (1993, p.174).

2799

REGIME DYNAMICS²⁾

As systems are **oscillators**, they tend to some sort of periodic regularity, i.e. to a dynamic regime. A dynamically stable regime correspond to a **toric** or periodic **attractor**.

However, a regime is not necessarily stable in the long run. Some very unfrequent environmental **disturbances** may unsettle **stability**, throwing the system "out of gear", either into another dynamically stable regime – possibly at a higher **level** of **complexity** if the **disturbance** is a permanently heightened **flow** of **energy**, or into **chaotic behavior**.

Any given regime is in many cases taken for granted. Such a mental rut is quite dangerous, because it leads to a false sense of security and eventually to dramatic awakenings.

2800

REGION¹⁾

An area in the **field** of a **state-determined system** in which the **lines of behavior** from all points remain located (after ASHBY, 1960, p.48).

According to ASHBY such a region is stable. From his comments and developments, it appears that "region" is practically a synonym of "**basin**" in **topology**.

He explains, for example that: "If a **line of behavior** is re-entrant to itself, the system undergoes a recurrent **cycle**. If the **cycle** is wholly contained in a given region, and the **lines of behavior** lead *into* the **cycle**, the **cycle** is **stable**" (p.49).

The region **model** corresponds more or less to the **field** concept. It has a practical value in any **situation** where a **group** or **population** (or whatever kind) is wandering in an **environment** with **resources** variable in **space** and in **time**.

→ **Foraging theory; Parasitism; Symbiosis; Value Theorem (Marginal)**

2801

REGRESSION (Organizational)^{1) - 4)}

The return to a former and lesser **level** of **organization**.

This notion has been introduced by E. SCHWARZ (1992, p. 771-2) who applies it mainly to **human systems**.

He writes: "We should mention the **distinction** between the dynamic coherent **differentiation** of the **morphogenetic** phase..., and the chaotic fragmentation of **structures** that often occurs in the alea sector around the **bifurcation**, in system fragilized by a tropic **drift** incompatible with their **components** and/or their **environment**. The destructure of the ex-USSR giving way to pre-communist countries, and the destructure of the Federation of Russia giving way to ethnic states, is an impressive example of a multiple turn organizational regression" (Ibid).

Tribal wars in Africa after the demise of global colonial political **structures** are another example.

This **process** reflects the implicit persistence of **parts** at lesser **levels** of **organization** within great **complex systems**.

2802

REGULATION^{1) - 2)}

1. "Any systematic (**rule-like** or determinate) **behavior** of one part of a system that tends to restrict the **fluctuations** in **behavior** of another **part** of that system" (K. KRIPPENDORFF, 1986, p.64).

Regulations translate **constraints** through appropriate devices, i.e. **regulators**. They are one of the most general and fundamental feature of systems in their dynamic dimension and appear in practically every aspect of natural or constructed ones.

KRIPPENDORFF states: "While both **parts** must lie in the same **feedback loop**, regulation involves this basic **asymmetry**: the **regulator** detects and responds to discrepancies from some expectation (**criterion, goal**) which is of an ordinality higher than the **behavior** so assessed and it computes the **actions** appropriate to keep the **behavior** to be regulated within desirable **limits**" (Ibid).

Regulation and **control** are merely *near* synonyms. Regulation seems more general, as many natural regulations (in **ecosystems**, in **living systems**, and even in **social systems**) are automatic. **Control** implies generally the introduction by a human **decider**.

2. **Stabilization** of the completed **structures**" (1977, p.152).

J.L.L.E MOIGNE interprets regulation as a special case of a more general phenomenon, "**equilibration**", which includes as well the **stabilization** of the not yet completed **structures**, "themselves in **morphogenetic evolution** within the **fields** of forces of the modeled **object**" (Ibid).

LE MOIGNE insists (opportunistly, it seems) on the difference between regulation and **control**. The latter involves most generally the notion of strictly pre-programed ordering of the **process**, in the way it was introduced by the original **mecanicist cybernetics** and implies a considerable rigidity.

LE MOIGNE coincides with K. BERRIEN's view according to which regulation needs no **memory** to be adaptive (1968). It seems however obvious, that a **regulator** needs at least some permanent trace of the past of the system, be it under the guise of a predefined optimum **state** or a list of acceptable **states**, or be it a register of acceptable minima or maxima. Such traces are easily overlooked, specially in natural **regulators**.

A wide-embracing survey of the subject (in French) can be found in A. LICHNEROWICZ et al (1977).

2803

REGULATION (Developmental)⁵⁾

"The sequential **activation** of a series of regulatory **switches** that in turn activate **networks** of other genes" (D. ERWIN et al., 1997, p.133).

This is a very general biological **mechanism** at the genetic **level**. The authors state: "Many different **classes** of regulatory genes share a common DNA sequence known as the **homeobox**, which predates the origin of animals" and ... "In complex **organisms** the **hox cluster** specifies the **development** fate of individual

regions within the body, and usually the genes are activated and expressed in the body in the same order as their **position** in the **cluster**" (Ibid).

Note: "Hox" is shorthand for "homeobox"

→ **Morpho-space; Timekeeper**

2804

REGULATION (Emergent)²⁾

A regulation at a higher **level** of **complexity** resulting of the **coalescence** of **damping** devices.

G. NICOLIS and I. PRIGOGINE have shown "that the **evolution** of a **fluctuation** depends on the **competition** between **growth** and **damping** through **diffusion** or, more generally, through **surface effects**" (1977, p.462).

If a **runaway fluctuation** gets totally out of **control**, it will destroy the system. While this sometimes happens, **damping** through new types of limitative **interactions** generally appears. It tends to become a permanent **effect**, through repetitive **sequences** and thus becomes a new **regulation** at a higher **level**.

This **process** is clearly the root of higher **level regulation** in societies in formation **process** (animal or human). It is related, for example, to pheromones in anthills or beehives, and to **values** and legal devices in human societies.

2805

REGULATION (Ergodic)²⁾

A regulation that, with **time**, becomes independent from the initial **state** of the system.

J. EUGENE writes: "Only a system that counts with at least one **feedback** coupling is able to develop itself in an ergodic way" (1981, p.65).

The ergodic regulation corresponds to an "**ergodicity domain** within which the very young system may not be able to resist small **disturbances**. When becoming mature, the system acquires a resistance to strong **disturbances**, until, finally it loses any resistance to any kind of disturbance" (Ibid).

J. EUGENE adds the noteworthy following comment: "Such ergodic **processes** correspond to von BERTALANFFY's **equifinality**. Their interpretation led formerly to metaphysical finalism, specially in relation to **phenomena** of biological **regeneration**, as described by Hans DRIESCH (1909). This author sets that the **organism's** development is conducted by a force, which he calls "**entelechy**". (The concept of **ergodicity**) shows that finalistic and metaphysical concepts are not needed to explain the development of systems. Such development, of a dialectical nature, results of the disequilibrium of a system in which the values of the **inputs** (Xt) and the **outputs** (Yt) are in a permanent contradictory movement, the **outputs** modifying the **inputs**, which in turn modify again the **outputs**" (p.67).

The theory of ergodic regulation has been developed by and W. Ross ASHBY (1956) and O. LANGE (1965).

2806

REGULATION (Polycentric)^{1) - 2) - 4)}

The existence of various **regulators** at different **levels** and places in a **complex system**.

A completely centralized regulation in a quite **complex system** faces the problem of **time lags**: in many cases the central **regulator** acts upon conditions that have already changed and becomes inefficient, if not downright harmful. Moreover, when long **communication lines** are needed, **noise** may distort the **information** (both **bottom up** and **top down**) and induce inadequate **responses**.

While a global **regulator** is still needed in order to maintain the general **coherence** in the system, regulation may at least be partially decentralized. Local and specific **regulators** may be set up, in conformity with the **heterogeneous** character of the system. This leads to a degree of **heterarchy**, giving **autonomy** to functional **subsystems**.

This type of organization exists in physiology. It could be generalized in **human systems**, and even probably in complex artificial systems.

2807

REGULATION (Self)^{1) - 2) - 4)}

Regulation that arises from the nature of the constituent **parts** of the system and their interplay.

Self-regulation is related to the **complementarity** and the satisfactory **integration** of **parts** or **subsystems** in the system.

It implies the **co-variance** of the systems **functions** and, normally, the existence of **hierarchical control** and of a central **control subsystem**.

The capacity of self-regulation endows the system with a degree of **autonomy**, within the specific and differentiated **limits** it embraces.

In human systems as enterprises, **organizations**, cultures, etc...any modification of **functions** or **subsystems** or relations with the **environment** should be carefully studied and planned, in order to avoid deep **perturbations** or even destruction of the self-regulation ability.

2808

REGULATION (Self) in Societies⁴⁾⁵⁾

Sociologists and theoretical economists of the past described self-regulation in societies under various guises long time before its cybernetic **modelling**.

F. CAPRA gives the following examples: "The best known, perhaps, are the "invisible hand" regulating the market in the economic theory of A. SMITH, the "checks and balances" of the US Constitution, and the interplay of thesis and an-

tithesis in the dialectic of HEGEL and MARX. The **phenomenons** described by these **models** and **metaphors** all imply **circular patterns** of **causality** that can be represented by **feedback loops**" (1977, p. 62)

However, as also stated by CAPRA "...but none of these authors made the fact explicit" (Ibid)

As a result these **models** (with the exception of the "checks and balances" of the US Constitution) became all more or less ideologically tainted in their applications, with at times, very dubious results.

Accordingly, in human systems as enterprises, **organizations**, economic and in political law making, any modification of **processes**, **functions**, **subsystems** or **relationships** with the **environment** (previously clearly described) should be carefully scrutinized. Any subsequent **planning** should watch for **underconceptualization**, in order to avoid what is generally known as "vicious circles".

These are in fact uncompensated and unilateral **positive** or **negative feedbacks** unwittingly introduced.

This is also the case with so-called "self fulfilling prophecies".

→ **Design**

2809

REGULATOR^{1) - 2)}

Any device whose use is "to keep the **output variables** of the system constant in spite of **disturbances**, which are represented by the **input variables**" (G. KLIR, 1991, p.155).

Any **input** can indeed be viewed as a **disturbance**, even if necessary for the system: ingested food, for example, must be appropriately **metabolized** under **control** of physiological regulators.

Regulators are generally **error-controlled**. In the words of ASHBY: "In this case the regulator's **channel** for **information** about the **disturbance** has to pass through a **variable** (the "error") which is kept as constant as possible (at zero) by the regulator R itself. Because of this route for the **information**, the more successful the regulator, the less will be the **range** of the **error**... To go to the extreme: if the regulator is totally successful, the **error** will be zero unvaryingly, and the regulator will be cut off totally from the **information** (about D's value) that alone can make it successful - which is absurd. The error-controlled regulator is thus functionally incapable of being 100 percent efficient" (1958, p.93)

(D is for **disturbance**) (See hereafter: "Regulator Paradox")

However, as stated by R.C. CONANT and W.R. ASHBY: "Error-controlled regulation is in fact a primitive and demonstrably inferior method of regulation... The regulations used by the higher

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

organisms evolve progressively to types more effective in using **information** about the causes (at D) as the source and determiner of their regulatory actions" (1981, p. 190)

This is related to **anticipatory behavior**, **early warnings** (as **disturbances** are announced if and when their forerunning causes are perceived or registered), and **feedforward**.

2810

REGULATOR PARADOX (The)³⁾

Regulators need necessarily be able to perceive *errors*. Out of this condition, a paradox does arise, stated in the following terms by B. PORTER: "If the regulator were totally successful, the **error** would exhibit *no variety*, the regulator would accordingly receive no **information** about the external **disturbances** acting upon the plant, and successful regulation would thus be impossible" (1976, p.228)

This could however imply a logical fallacy, as **disturbances** could obviously produce a **variety** of **errors**, and thus *waken* the regulator.

2811

REGULATORS (Short history of)¹⁾

Practical and effective regulators anticipated for long time the **cybernetic** theory of **regulation**. Some examples can be found in various antique cultures and even in archaic ones. Some old Chinese and Medieval artefacts also included regulators.

R. VALLÉE makes the point: "The classical example of regulators, the best known of them being WATT's regulator (1785 – first theory due to MAXWELL around 1870) is a good illustration of **negative feedback**. Nevertheless it is not the most ancient: middle ages and antiquity give other examples such as the mill corn-dispenser, or clepsydra water supply" (1993a, p.85).

2812

REIFICATION^{1) – 3)}

The fallacy to treat or regard an **abstraction** or a **model** as a **concrete system**.

This "fallacy of misplaced concreteness", in WHITEHEAD'S words is one of the most serious risks that a systemist can incur in. It has two different aspects:

1) The danger to construct a pure and unqualified **abstraction** and to use it or work on it as if it were part of the real world. Examples could be: "Homo economicus"; "the State", "Development", etc., and even possibly "Intelligence quotient".

2) The danger to use a constructed **model** of some **concrete system** as if the system were a faithful (i.e. **isomorphic**) *copy* of the **model**.

Such attitudes are ruinous for the credibility of **systemics**.

2813

REINFORCEMENT¹⁾

The strengthening of some characteristic in a system by repetition of a **stimulus-response** effect.

Reinforcement cannot occur against unfavorable **selection** pressure. It generally starts as a **random** effect, which leads to a more satisfactory **situation** and thus becomes favored if repeated.

Reinforcement can be automatic, as for example in natural **selection** resulting in the multiplication of some genes in a **population** after a mutation, favorable in specific conditions. It has also been considered as a basic condition of animal or human **learning** by behaviorists. Devoid of its purely mechanistic taint, it is not rejected by so-called cognitivists, provided it be conjugated with recognition **memory**. (H.L. PETRI and M. MISHKIN, 1994, p.30-37).

In **learning**, according to these authors: "The role of reinforcement... is not to change the probability of a given **response**, but to lead to the development of expectancies about how certain **goals** can be reached" (Ibid., p.30). Reinforcement can possibly be used as a tool by **purpose** seeking systems.

The concept also can be extended to recognition **processes** in **automata** and, possibly to global **behavior** in **automata networks**.

→ **Hebb's rule**

2814

REJECTION REACTION¹⁾

Expulsion or neutralization by a system of **elements** coming from its **environment** and not compatible with the **maintenance** of its **dynamic stability** or **autopoiesis**.

The **elements** which are absorbed by the system may prove to be assimilable or not. A non compatible **element** cannot enter in the **functional cycles** of the system and may very well perturb or even destroy them.

However the systems possess various defensive devices depending of their **central control subsystem**, and whose specific **function** is to neutralize the perturbing **elements**. The best known is the immune reaction, but similar mechanisms seem to exist in any **complex system**.

The dysfunction of these mechanisms turns defenseless the system. However they themselves may become perturbing agents, when functioning in an faulty way. Allergies and anaphylactic reactions are examples of such negative results.

2815

RELATION¹⁾

"A property or properties of a **set** of **objects** and/or **events** that they do not have when taken separately" (R.L. ACKOFF & F.E. EMERY, 1972, p. 255).

These authors illustrate their definition as follows: "If John and Mary are married, then married is a property of the pair" (Ibid).

An other good example is water (H₂O) whose properties result from the chemical bond between two H and one O, while however inexistant if these atoms are not binded in the specific H₂O molecule.

Specificity implies that relations are necessarily *non-stochastic* coupled **interconnections**.

St. BEER refers to an "Axiom of Internal Relations" enunciated by HEGEL, according to which "... the relations by which terms are related are an integral part of the terms they relate" (1968, p.242).

It would possibly be clearer to say that any **element** acquires new polarities when it becomes **part** of a **set** or system. In effect, relations are in many cases only potential or intermittent.

The simplest relations are **dyadic**. However, many **dyadic** relations lead to the production of a third **element**, transforming the relation into **triadic**.

I.I. MITROFF and H.A. LINSTONE indicate that "... the number of possible relations among **subsets** in a system comprising only three **elements** is at least 49. In general, one has (2ⁿ - 1)² relations, where n is the number of **elements**. A system comprising ten **elements** thus may involve at least 1 million possible internal **relationships**" (1993, p.115).

As a result, many significant relations can easily be overlooked, particularly in very complex social systems. Those considered are not necessarily the most significant, according to BEER's following suggestive comment: "In practice however, we acknowledge relatedness only when we are ready to declare its **relevance**" (Ibid).

This implies a possible problem: In many cases, some relations exist, but, as **observers**, we do not perceive them. Moreover, **relevance** itself is a matter of **criteria**, not always clearly conceived or enounced and, in any case, relative to the **goal** we try to achieve.

The methodic search for meaningful relations and for meaningful **criteria** to be used in this search is without doubt one of the most important topic of systems research.

2816

RELATIONS Taxonomies^{1) – 2)}

J. WARFIELD resumes as follows the seven basic **categories** of relations, as established by A.De MORGAN in 1847 and adapted by C.S. PEIRCE around 1900:

- Empty (Null)
- Universal
- Reflexive
- Symmetric
- Asymmetric

- Hybrid
- Transitive

These **categories** are a fundamental basis, together with the six basic types of **relationships** for the **Generic Design Science** as proposed by WARFIELD (pers. comm.). He considers De MORGAN theory of relations as "a higher grade version of the theory of **sets**. Everything in **set** theory is incorporated in the theory of relations. However, the theory of relations allows the use of any kind of **relationship** in its formal **operation**, while the theory of **sets** only formalizes two types of **relationships**: **implication** and **exclusion**.

The theory of relations also leads to "**definition by relationship**", considered by WARFIELD as the highest grade of **definitions** (1988, p.336).

J. FEIBLEMAN and J.W. FRIEND list as follows the different kinds of relations which may exist between the **parts** of an **organization** or **elements** of a system:

- | | |
|--|-------------------------|
| (a) transitivity | (-a) intransitivity |
| (b) connexity | (-b) non-connexity |
| (c) symmetry | (-c) asymetry |
| (d) seriality (transitive, connected, asymmetrical) | (-d) aseriality |
| (e) correlation (one-many, one-one, many-one, many-many) | (-e) non-correlation |
| (f) addition | (-f) non-addition |
| (g) multiplication | (-g) non multiplication |
| (h) commutation | (-h) non-commutation |
| (i) association | (-i) non-association |
| (j) distribution | (-j) non-distribution |
| (k) dependence | (-k) independence" |

The authors add: "There may be other relations between **parts** in any concrete **organization**... But such relations do not bear on the question of **organization qua organization**" (1969, p.31-2).

(See entries corresponding to these different types of relations in their alphabetic order).

In a more common sense, the most frequent types of relations are: "**interaction, interconnection, coupling, linkage, cohesion, constraint, interdependence, function, organization, structure, association, correlation, pattern, etc...**" (G. KLIR, 1991, p.10).

KLIR also identifies **compatibility, homomorphism or isomorphism** (in **models**) and ordering.

Still from another viewpoint, a relation can be space-invariant, support-invariant or **time-invariant** (p.53-7).

2817

RELATIONS (Time-invariant)²⁾

G. KLIR proposes the following classification of these relations:

1. **Absolute relations**: "which are satisfied over the entire **time** interval of any activity of the given system.

2. **Relative relations**: "which are satisfied anywhere within a particular activity of the given system".

3. **Local relations**: "which apply only within some shorter time intervals of a particular activity" (1965, p.3).

Correlated to these different types of time-invariant relations, KLIR establishes three kinds of basic **behavior**: permanent, relatively permanent and temporary.

2818

RELATIONSHIPS¹⁾

J. WARFIELD characterizes as follows the six basic types of interpretive relationships used as a systemic basis for his General Design Science:

"**Definitive**: includes, is included in, implies, is a member of, is in the same **category** as...

"**Comparative**: is greater than, is heavier than, is preferred to, is of equal or higher priority with...

"**Influence**: causes, affects, aggravates, enhances...

"**Temporal**: must precede, follows, overlaps in time.

"**Spatial**: lies east of, lies above...

"**Mathematical**: is a function of, is computable from, is less than or equal to, affects the likelihood of...

"The brackets contain examples, but are by no means exhaustive of the set of possible relationships of each type" (1994b, p.60)).

2819

RELATIVITY POSTULATE^{1) - 3)}

"Any hypothesis valid for A as well as for B must be rejected if not valid for A and B together" (H.von FOERSTER, 1992, p.84).

von FOERSTER justifies his postulate giving as an example Ptolemean cosmography. Earthians and Martians could both believe their own planet to be the center of the planetary system, *but only in base of two different cosmographies*. However only the Copernican description is non-contradictory: "Every planet on its own and all of them together could move around the sun, without any logical contradiction: The heliocentric system validates the relativity postulate" (p.84).

This is indeed a very interesting conceptual generalization of physical relativity.

2820

RELATOR¹⁾

"A **sign** that relates the signification of one **sign** to that of another" (R.L. ACKOFF & F.E. EMERY, 1972, p.175).

According to ACKOFF and EMERY, a **relator** may attribute a property to a pair that cannot be attributed to either member taken separately. It also may introduce comparisons, either qualitative or quantitative.

2821

RELATORS (Arithmetic)²⁾

A formalized **language** based on arithmetics, whose aim is to modelize a great variety of systemic **dynamics**.

This **language** has been elaborated in France by a number of researchers under the leadership of Th. MOULIN at the "Ecole Nationale Supérieure de Techniques Avancées" (Groupe de recherches SYSTEMA).

As an example, MOULIN applies the **model** to neuronal systems. He writes: "Our long term purpose is to find a relation between "parallel" **descriptions** associated to **morphogenetic** potentials and "sequential" **descriptions** which fix at several **levels** the "elements of displacement" and, consequently the **dynamics**. This relation would integrate linguistic and informational aspects and would generalize the classical flux-strength equations" (Groupe Systema, E.N.S.T.A, 1988)

The **models** seems to have a potential for numerous applications. They are however quite abstract and the proposal should be studied directly from the sources.

2822

RELAXATION¹⁾

The return of a system or **process** to **equilibrium** after a **disturbance**.

This **behavior** is a characteristic of **dynamic equilibrium**, or **homeostasis**, when the admitted variations remain within a closed **basin**.

2823

RELEVANCE^{1) - 3) - 4)}

The character of something which is related to, or pertinent, in relation with an investigated **issue**.

Elements, events, environment are considered relevant for a system if, at least in some cases and sometimes, they exert an influence on its **behavior**.

Of course, **criteria** of relevance are defined by the **observer** and his/her specific viewpoint. They are thus never absolute and, in many cases, may even be illusory.

From a systemic viewpoint, we could tentatively distinguish:

Underconceptualized relevance: Relevance is considered only from a very narrow viewpoint by an individual or a small group merely interested in an ill-understood and/or ill-conceived circumstantial and very limited **issue**. In most

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

cases no serious research is done, or taken into account. In some, serious (or spurious) research may even be used as an ad-hoc tool to further some dubious **objective**.

This type of viewpoints is very common in day-to-day politics.

Broad relevance: Relevance is considered in a **long term** and wide embracing perspective. This supposes a clear definition and a broad **inquiry** about the system considered and also of the motives, expectations and **goals** of all the **stakeholders**. However, research excessive in scope and in time may lead to procrastination.

In big **issues**, as for example great public works, the **limits** of relevance should be clearly defined, justified and explained.

Overconceptualized relevance: Relevance is considered in such a vast space and time perspective that it becomes... irrelevant for any practical **purpose**.

In such cases, red-hot **issues** may remain unattended while spurious research and abstract debates linger unconvincingly on.

A good **understanding** of systems and their conditions of existence and **survival** is instrumental in defining **criteria** of relevance at any **level**.

On the contrary, the lack of appreciation of the relevance of some **events** or **elements** for a given system leads to unwarranted **simplifications** and, at times, very costly **errors**.

→ **Underconceptualization; Invisibility**

2824

RELEVANCE (Criteria of) ¹⁾³⁾

The **elements**, or **issues** that are relevant in the **management** of any kind of **situation** should be carefully evaluated through a study of the nature of their impact and the intensity of the same.

This implies a systemic -cybernetic **inquiry**.

On the other hand no such inquiry can totally escape from personal prejudice. As a result, the aspects taken in account must be also scrutinized from that viewpoint. Very interesting ways to avoid **underconceptualization** are by using techniques of **generative dialogue** in **design conversation** (B. BANATHY), **interpretive structural modeling** (J. WARFIELD), or **interpretive systemology** (H. LOPEZ GARAY and R. FUENMAYOR)

In all cases, **conversation** and **consensus** are needed to avoid dubious and/or excessively subjective **evaluations** about the different aspects taken (or not taken!) into account. But, of course, strictly objective criteria of relevance cannot be established. In fact, it seems that we are still in want for a good theory of relevance (D. HOFSTADTER, 2000, p. 50-51)

RELEVANT SYSTEM

→ **System (Relevant)**

2825

RELEVANCE of a model ^{2) - 3)}

Character of a **model** "well adapted in relation to some finalities that can be explicitated" (J.L.LE MOIGNE, 1977, p.13).

LE MOIGNE opposes "relevance" to "evidence" and quotes the following comment by P. DELATTRE: "It is by way of what we ignore that slogans become inserted into us (the "evidences") which, by dint of repetitions, bring us the certainties that our mere **knowledge** could not justify" (1971, p.22).

The concept of "model relevance" is closely linked to the one of "**idoneity**", proposed and widely explored by Ferdinand GONSETH (1945, p.57-67).

The comparison of the concepts of relevance and evidence decisively relativizes DESCARTES first principle, as stated in his "**Discourse on the method**".

2826

RELEVANCE TREE ANALYSIS ²⁾

"A technique... based on the general principle that, in any **hierarchical situation**, the **norm** for **parts**-performance is system-performance" (E. LASZLO, 1974, p.126).

While this **Systems Analysis** technique thus defined by E. LASZLO implies a good ordering principle, it does not inevitably mean that the global system performance **norms** are sound... in which case the technique may be wrongly used.

2827

RELIABILITY (Interrelated)

→ **Venn diagrams**

2828

RELIABILITY in dynamic terms ¹⁾⁴⁾

The reliability of physical or mechanical systems follows a characteristic curve in time. The **curve** includes three successive regions:

- the early or "youth" period when the systems have a high, but swiftly declining failure **rate**, as a result of the quick elimination of those who were defective because of some construction fault
- the useful **life** period when the failures are at their minimal **level**, during a quite long **time**, as the defective systems have been eliminated
- the **breakdown** period, when a quickly growing number of systems fail due to **wear** and aging

Of course, at each stage, reliability can be tested through appropriate methods.

An intriguing question mark is if and how this concept of reliability could be applied in the case of human systems: enterprises, political systems, or cultures among others

→ **Automata (Reliability of); Redundancy**

2829

RELIABILITY of a machine ^{1) - 3)}

An evaluation of the capacity of a **machine** or system to functionally survive the **breakdown** or impairment of some of its **parts**.

In parallel or **neural networks** and generally in complex systems, the breakdown of some **elements** or some unexpected **inputs** do not usually inhibit seriously the system's capacities, or limits only slightly its operative power. This is because computing or **operation** is *distributed* in the **whole** of the parallel **network**, which is considerably **redundant**.

However, when disabled, the **network** must undergo a reorganizing **process**, in order to create new internal **connections** to replace those which have been destroyed. A good example is the reconstruction of physical abilities and **knowledge** in persons which have been affected by a not overly destructive cerebral haemorrhage.

The subject of global reliability in neural computation based on unreliable **components** has been first considered by J.von NEUMANN (1956).

2830

RELIABILITY of a System ¹⁾²⁾

The measure of the **probability** that a system will perform some requisite function within specified conditions and during a specified **time**.

This measure is basic for **risk analysis** and **forecasting** applied for now mainly to physical and mechanical systems.

It includes a statistical and **prospective** study of possible causes of failures.

2831

RELIGION : A systemic view ¹⁾⁴⁾

Many authors have insisted on the etymology **meaning** of religion: re-ligare which means basically "interconnect".

From such a viewpoint, religion is a typical systemic social device, of a universal character.

All religions creeds, of whatever kind, offer similar characteristic traits:

- offering a set of **beliefs**, **values**, commandments, myths, ritual practices and standardized **behaviors**
 - imposing them as conditions to become and remain a member of the religious brethren
 - excluding as "heretics", "infidels", or "renegates" those individuals who do not adhere to or do question the credo
- It is thus clear that:

- the basic **elements** of any credo lead to an also basic psychological **similarity** among millions of individuals
- such uniformity fosters a sense of **community** membership in the thus conditioned individuals
- the shared credo creates specific **community structures** and ushers ordered collective behaviors
- those individuals who do not share the credo are generally excluded from the community and easily become rejected outcasts and may even be killed.

On the other hand, the existence of different religious **groups** of such characteristics explains rivalries, proselytism, fundamentalism, fanaticism and **culture conflicts**

2832

REMODELING ²⁾ - 4)

"The replacement of the existing **frame** of thinking with a newly-articulated **frame**" (J. WARFIELD, 1989a, p.9).

This **process** is also called "**framebreak**" by WARFIELD, who considers it essential to diminish and if possible eliminate **underconceptualization**, specially in the understanding of **complex systems** (Ibid).

WARFIELD proposed a technique for remodeling, whose aim is to enlarge as much as possible the mental outlook of the participants (1989 b, p.39-41).

→ **Revalidation**

2833

RENORMALIZATION GROUP TRANSFORMATION ²⁾

A transformation that ensures **self-similarity** of a **function** at different **levels**.

(See "**Self-similarity in the WEIERSTASS function**")

2834

REPAIR ¹⁾

"Replacement of a **part** of a **structure** either by a structural replica or a functional equivalent" (O.R. YOUNG, 1964, p.76)

In living and generally social systems, repair is automatic within limits, through autopoiesis.

→ **Breakdown; General Adaptation Syndrome; Maintenance**

2835

REPEATABILITY ¹⁾

The possibility of reappearance of some characterized **context** or **situation**, as perceived by an **observer**.

G. BATESON considers "The conventional assumption that **context** can be repeated, at least in some cases ... as a cornerstone of the thesis that the study of **behavior** must be or-

dered according to the Theory of **Logical Types**... Without the assumption of repeatable **context**... it would follow that all 'learning' would be... **zero learning**" (1973, p.259).

Of course, repetition of **context** is never perfect. It is only indispensable that it be sufficiently repetitive to allow for anchoring a useful **understanding** of some observed **phenomena** or for some **behavior** coherent with formerly learned properties of the **context**.

2836

REPELLOR ²⁾

Any active **behavioral limit** where a system tends to backtrack toward a more balanced **dynamic equilibrium**.

R.H. ABRAHAM and C.D. SHAW use this **model** in their **topological representation of self-organization**. Repellers are in fact **separatrices** considered as dynamical features in **attractors** (1987, p.550).

"Repellor" could also be considered a near synonym for **critical threshold**.

2837

REPertoire (or REPERTORY) ¹⁾

A set of possible **patterns of behavior** in a system.

Repertoires are learned and slowly become fixed as the system matures. They then form the base for **dynamic stability maintenance**. They are limited in accordance with:

- the basic nature of the system, reflected in its **organizational closure**;
- The way the system interacts with its specific **environment** during its **learning period**. (See for example "**Knowledge construction**").

2838

REPLICATION ¹⁾

The direct or cyclical **production** of **elements** in a system or a **population**.

The reproduced **elements** may be similar to or different from the initial ones. But all must be compatible with the system to which they pertain.

For M. EIGEN, replication is the condition for the shaping of **populations**, from which different types may form **quasi-species**, each time that some **error threshold** is crossed during replication.

From another viewpoint, V. CSANYI writes that, in order to operate replication: "... the constructor needs a **description**, the **information** necessary for the copying **process**. The essence of replication is the **function** of copying regardless of the particular mechanisms of **storage** and retrieval of **information**. It does not matter whether this **information** is stored separately (as in the case of DNA for example) or is distributed in the **whole** system (as in **society**)".

CSANYI also distinguishes **temporal replication** "as the continuous renewal of the system in **time**... (in a way) sufficient to maintain the unity and **identity** of the system and its **organization**"; and **spatial replication**, in which: "the system produces its own copy, which becomes separated from it in **space**" (1993, p.262). This is for example the case of cellular reproduction.

The first case corresponds to **autopoiesis**, while the second accounts for the **growth** of **populations** of some specific type of system, as cells or amoeba.

According to V. CSANYI and G. KAMPIS: "Replication is an imperfect copying of the **components** directed by **information** (that is) located... in the **component** itself or is distributed within the system" (LASZLO, 1991).

This is practically equivalent to **autopoiesis** and to **hypercycle** reproduction.

Any system needs an **autogenic** precursor, whose characteristics reflect a specific combination of **information** received from former systems.

The authors call "**zero-system**" such a not yet developed **network of components** (G. KAMPIS & V. CSANYI, 1986).

→ **Archetype**

2839

REPLICATOR ¹⁾ - 4)

Any **element** "able to create copies of itself" (R. DAWKINS, 1992, p.16).

DAWKINS writes: "Think of the replicator as a mould or **template**" (Ibid) and he proposes the following construction **rules**:

- there is an abundance of diverse types of building blocks around the replicator
- each building block may have an affinity for its own kind, - or possibly for some other specific kind - situated somewhere in the replicator

As a result, they may be able to attach themselves "in a sequence which mimics that of the replicator itself" (p.17).

Crystals are replicators.

Replication also exists, in different forms, in **living systems**: DNA - amoebas - cells. It would be interesting to study the public opinion **phenomenon** from the same viewpoint. The Swiss engraver A. BÖCKLIN produced in the 19th Century a print suggesting precisely this.

Replicators can be modeled as **automata**. For the time being, such automata are still **computer models**, whose concept developed out of von NEUMANN's model of **cellular automaton** known as "universal constructor". The state of the art has been described recently by M. SIPPER & J.A. REGGIA (2001)

The possibility to create material **self replicating automata** seems to become real and is related to the so-called **Artificial Life**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

For an interesting comparison between **memes** and **genes**, both considered as replicators, see S. BLACKMORE (2000, p. 56-8)

→ **Fitness function; Paralled Distributing Processing; Synaptic Weights**

2840

REPORTING DENSITY²⁾

→ **Venn diagrams**

2841

REPRESENTATION³⁾

1) "A **set of signs** for **communication** of the features of some **entity** or system" (J.Z. YOUNG, 1974, p.298).

2) "Any **structure (pattern, picture, model)** whether abstract or concrete, of which the features purport to symbolize or correspond in some sense with those of some other **structure**" (D. Mac KAY, 1969, p.161).

3) "A **set of concepts and rules** that must be used in creating a **description** from a certain point of view, or from a certain **class** of points of view that are equivalent with respect to some conditions, that are characteristic of the representation" (G. DALENOORT, 1989, p.15).

4) The result of our ways to observe reality and construct **models** of it (inspired from J.J. GIBSON).

The definition by YOUNG shows that the production of any type of **model** depends on the type of **code** being used. A representation is thus senseless for someone who ignores the **code**.

Mac KAY adds the following comment to his definition: "The physical **processes** concerned in the formation or **transformation** of a representation are thus distinguished from other physical **processes** by the **element of significance** which they possess when conceived as representing something else."

"For any given **structure** there may be several equivalent representations, defined as such through possessing certain abstracts features in common" (Ibid).

Mac KAY's concept of representation is practically equivalent with the systemic concept of **model**.

According to DALENOORT: "Whereas the term '**description**' usually refers to a single system or **model**, the term 'representation' refers to **classes** of systems, and the characteristics of the **set** of concepts and **rules** involved" Moreover he distinguishes:

- **causal** representations versus **goal-directed** representations, and

- representations according to different **levels of aggregation**" (Ibid., p.15).

J.L.LE MOIGNE quotes J. LADRIERE: "In representation there are, as to say, two types of presence: the effective presence of a person, an **object**, an **action**, and the indirect presence, mediated by the former, of a reality that does not belong to the **field of direct perception**" (1977, p.45).

J.L.LE MOIGNE adds that what he calls "**systemography**" aims at "representing the **object** as significant and as a functioning **organism**" (Ibid). In other words, any representation is an "ad hoc" **observer's** representation.

The problem of representation raises very difficult **epistemological** and **ontological** questions. J.J. GIBSON, for instance, who proposed an **ecological** approach to (visual) **perception**, even states that: "The efforts made by philosophers and psychologists to clarify what is meant by a *representation* have failed, it seems to me, because the concept is wrong... (A picture) is not a substitute for going back and looking again. What it records, registers, or consolidates is **information**, not sense **data**" (1986, p.280).

Of course, it becomes **information** and, as such, can be modified by further **observation**, because of the capacity for interpretation by some **observer**, in his/her own terms, thus "making sense" of it.

On the question as if we are somehow able to reach reality through our constructed representations of it, F. BONSACK states:

"First of all we must avoid the trap implicit in the **ambiguity** of the term 'representation'. What is a representation? The global and instantaneous **perception** that I have at this moment of the scene that surrounds me? The succession of **perceptions** that I obtain by inspecting successively details of this scene? The checkings that I may perform by a closer inspection, by manipulating or testing some of the **objects**? or yet, the organized **models** of the world that I construct myself, in order to integrate, organize and interpret as a coherent **whole** all these instantaneous **perceptions**, together with all those about which I received indirect **information**?"

"If we say that we have access only to representations, it may be suggested that a representation is its own measure, that it can be verified only by comparing it to another representation – which is not really a verification, as both are prejudiced in the same way. However, such is not the case if we take in account the different possible **levels** of representation. I am able to correct a first global **perception** by focusing my attention upon certain details; by manipulation and testing I may correct my world's image if it is not compatible with certain new experiences obtained either by global instantaneous **perception**, or in detailed **perception**, or because I have conducted some more or less sophisticated manipulations.

"Thus, my **criterion** is not merely the inter-subjective **consensus**, it is firstly and mainly the correspondence of this different **levels** of representation. I may well concord with the overwhelming majority about a geocentric model of the world, but this will not curtail new discovery, or a new interpretation of known **data**, which show that such a **model** is not the best and that another one is simpler, more coherent and more fruitful. The decisive coincidence is not between theoretical discourses or even descriptive ones of the scientist. It is between what this discourse predict and which is effectively perceived through experience" (1990, p.155-6).

In any case, and to put in a simple way as done by A. KORZYBSKI: "The map is not the territory" (which does not mean, of course, that the territory does not exist. And, as noted by A.L. GOUDSMIT: "... external world and internal representation are assigned different Russellian logical types" (1989, p.169).

Synthetically, any **consensus** – at least any scientific one – needs to pass POPPER's falseability test, again and again. It could be said however that the nature and **idoneity** of such tests is again a matter of **consensus** among scientists. Thus, our conclusions are still... inconclusive and probably will remain inconclusive for ever: a "decisive" coincidence is not necessarily a definitive one.

2842

REPRESENTATION (Active or latent)³⁾

Active representation, according to Fr CRICK and Ch. KOCH is the **process** of explication of an implicit representation present in our neural **network** and evoked by some **perception**, through a **pattern** of firing neurons.

These authors write: "A latent representation of a face must also be stored in the **brain**, probably as a special **pattern** of synaptic **connexions** between neurons... For example, you probably have a representation of the Statue of Liberty in your **brain**, a representation that usually is inactive. If you do think about the statue, the representation becomes active, with the relevant neurons firing away" (1992, p.112).

Of course, there is still a need to explain how these latent representations become established, through some initial **perception**, internally transformed and made available for retrieval.

In R. FISCHER words, who applies the notion to **parallel distributed processing**, "... what was learned is not a representation, but the **state** of all... **neuron-like connections**" (1992, p.212).

This is the latent representation capacity, out of which we may at will obtain instant representations of what we "know", according to what and how we "know".

2843

REPRESENTATION ARTEFACT²⁾ - 3)

Any feature in a **model** that does not correspond to some characteristic of the **concrete system**.

This concept is introduced by D. GERNERT, who writes: "When systems of the real world are modelled on the basis of a finite **scheme** of representation, some **phenomena** may occur which are relevant only within the **model**, but have nothing to do with the underlying system..."

"In representing a function by a J. FOURIER expansion the well-known Gibbs **phenomenon** may appear, which means that there are peaks in the representation that have no counter part in the original function" (1994, p.126).

Representation artifacts are produced by some implicit feature of the **model** itself and pass easily unnoticed. This may lead to subtle errors, very difficult to discover.

→ **FOURIER analysis; Random walk**

2844

REPRESENTATION (Complex)¹⁾ - 4)

Fr. CRICK and Ch. KOCH state: "An **object**... may be represented in more than one way - as a visual image, a **set** of words and their related sounds, or even as a touch, or a smell. These different representations are likely to interact with one another. The representation is likely to be distributed over many neurons, both locally... and more globally" (1992, p.112).

One wonders if the same could be true in social **networks**: A social group or a culture could have complex global representations distributed through numerous interacting individuals, who would be quite unaware of the existence of a global representation. So-called "Public opinion" could be such a collective and complex representation.

2845

REPRESENTATION (Explicit and implicit)³⁾

According to Fr. CRICK and Ch. KOCH: "It is important to distinguish between an explicit and an implicit representation. An explicit representation is something that is symbolized without further **processing**. An implicit representation contains the same **information** but requires further **processing**. The **pattern** of colored dots on a television screen, for example, contains an implicit representation of **objects** (say, a person's face), but only the dots and their locations are explicit. When you see a face on the screen, there must be neurons in your brain whose firing, in some sense, symbolizes that face" (1992, p.112).

In other words, **patterns** of perceived **signals** acquire **meaning** only if we already have established internal neural **patterns** more or less in **resonance** with that which we perceive. Such **patterns** have necessarily a genetic base

and were constructed on this base by **learning**. Moreover, **learning** differs with social and cultural settings, which explains that similar **perceptions** may lead to different representations in different persons.

2846

REPRESENTATION (Quantal)³⁾

Mac KAY states: "Representations communicable in a two-valued (yes or no) form are necessarily **quantal** in **structure**, since an "imperceptible **change**" in a two valued logical form is by definition meaningless. All the **changes** are discrete, therefore the elementary concepts of logical representations are discrete and enumerable..."

"In general, a **pattern** reduced to such fundamental terms will contain a certain number of distinguishable groups or **clusters** of **elements**, the **elements** in each group being indistinguishable among themselves. There are thus two numerical features of interest:

- 1) The number of distinguishable **groups** or **clusters** of indistinguishable **elements** in a representation, and
- 2) The number of **elements** in a given **group** or **cluster**" (1969, p.164).

Thus, quantal representation can generally be matricial.

2847

REPRESENTATION (Structure of)³⁾

HEYLIGHEN states: "How **distinctions** are made (i.e., which **distinctions** out of the infinite number of potential **distinctions** are selected), and how they are connected, will determine the **structure** of a representation and, hence, its adequacy in predicting the observed **behavior** of the system" (1990a, p.427).

The built up of any representation is necessarily based on perceptive conditioning as well as perceptive intentionality. This is the global lesson of **ethology** (von ÜEXKÜLL, LORENZ and their successors) and of **phenomenology** of **perception** (von BRENTANO, von WEIZÄCKER, KÖHLER, KOFFKA, MERLEAU PONTY and others).

2848

REPRESENTATION SYSTEM²⁾ - 3) - 4)

Any **observer** must necessarily construct for himself a **set** of **rules** for the interpretation of whatever he perceives. In nearly all cases, this mental **structure** (or **cognitive system**) remains tacit, and even unconscious, while the **observer** thinks that he is applying the "natural laws of intelligence" and obtaining the **knowledge** of "reality".

In fact there are many representation systems, which are individual variants of great collective systems of cultural origin.

As shown by von FOERSTER, H. MATURANA and F. VARELA, every **observer** constructs his/her own representation system, which moreover are interdependent: "I exist through the others and they exist through myself; we are our reciprocal **feedbacks**" (H.von FOERSTER, 1992, p.85).

Representation systems can be rooted in myths, in some religious belief, in a philosophical system, in an ideology or in a scientific **paradigm**, for example. In some cases, they may present individual or collective pathological variants (personal or mass paranoia).

The present planetary **transculturalization process** tends to make manifest the existence, nature and characteristics of the various culturally grounded representation systems. (see for example MARIYAMA's work on **mindscape**s).

The necessity to understand and manage the numerous complex situations now created by man himself has given rise to a new representation system, the systemic one, which has been explored as such by authors like C. WEST CHURCHMAN (1971), H. SIMON (1969) and J.L.LE MOIGNE (1977).

LE MOIGNE writes: "The representation system... transforms the **object** to be modeled into a transmissible **model**". He proposes his "**Système Général**" concept "as a representation system for organized **complexity**" (1977, p.55-58).

2849

REPRESENTATIONAL SYSTEM²³⁾

The extensive and interconnected **set** of **images**, **models** and **concepts** used by an individual as a **categorizational** tool and general **reference frame** for observational and behavioral **purposes**.

Such a system can be considered as a **representation system** in **activity**, as it is always **used** to observe and describe **events** and **situations** to oneself and guide **behavior** and **action**. The effective use of a representational system implies thus **intentionality**.

It should be clearly distinguished from any **systems representation**, which is a specific **model** of a **part** of the observed world, constructed in accordance to **systemics**, which is in itself a quite general representational system.

→ **Affordance, Knowledge (Implicit); Perception**

2850

REPRODUCER¹⁾

"The **subsystem** which carries out the instructions in the genetic **information** or charter of a system and mobilizes **matter**, **energy** and **information** to produce one or more similar systems".

The reproducer is one of the **20 critical subsystems** in J. G. MILLER's **taxonomy of living systems** (1978, p.3).

2851

REPRODUCTION^{1) - 2)}

"Production by an **object** x1 of class X of an **object** x2 also of class X" (R.L. ACKOFF & F.E. EMERY, 1972, p.22).

Reproduction should not be confused with **self-reproduction**.

ACKOFF and EMERY observe that reproduction occurs many times through coproducers, which they define as: "Two or more **objects**, properties and/or **environments** that are producers of the same product" (Ibid., p.23). This becomes closer, but not identical, to **autopoiesis**. Sexual reproduction for instance, can be considered an **autopoietic mechanism**, but then only at the **species level**.

As observed by H.T. ODUM, **error-free** reproduction has a **cost** and, moreover becomes impossible in the long run, at least as to the **elements of complex systems** (1971, p.142).

The case of practically eternal correct reproduction of amoebas or bacteria remains a puzzle: Why does division, leading to total separation, maintain some kind of **identity** without limit in time, while **autopoietic complex systems** are always finally doomed to destruction?

2852

REPRODUCTION (Self)^{1) - 2)}

The ability of a system to maintain its **identity**, in spite of the progressive replacement of its **elements**.

This concept, practically equivalent to **autopoiesis**, was enounced in 1951 by J.W.S. PRINGLE in these terms:

(An open system) "has the following properties:

1. It is a **steady-state equilibrium**, each unit appearing to be constant only because it is being formed and destroyed at the same rate;
2. Either or both **processes** are subject to **variations**;
3. The **rate** of formation and the **rate** of destruction of each unit depend on different **functions** of the quantity present, and on the **environmental** conditions.

"These features imply a property of the units which may be called **"replication"**; that is, the presence of a unit in the system causes more similar units to appear, with an accompanying increase in **order** which is balanced at **steady - state equilibrium** by the decrease in **order** involved in their destruction" (1956, p.92).

Self-reproduction is one of those ambiguous terms in cybernetics and systemics. W.R. ASHBY, who died before the **autopoiesis concept** was fully explored, could write in 1962: "... be-

fore we start to consider the question of the self-reproducing system, we must recognize that no **organism** is self-reproducing" (1981, p.72).

His argument was that the **reproduction** of a system could never occur without a mobilizing **interaction** with some other system or with a specific **environment** and stated that "the adjective **"self-reproducing"** is highly objectionable **semantically** and logically" (p.72).

This did not deter him to dedicate his paper to the "Self-reproducing system". He came to the clear conclusion that self-reproduction terminology should be used only for **cyclical processes** of the type "A reproduces B, then B reproduces C, and then C reproduces A" (p.78) and recognized that "Such a **cycle** is of course extremely common in the biological world" (p.79)... where "All sufficiently large systems will become filled with self-reproducing forms" (p. 79).

Thus, genuine self-reproduction is always an **endogenous process**, and the **exogenous** production of a **whole** copy or the original system, as for example in some of J.H. CONWAY's Games of Life, should not be called self-reproduction, as it depends of an **algorithm** external to the original **configuration** itself, which, by the way, is also the case in biological (not self-) **reproduction**.

ASHBY was, after all, on his own way toward **organizational closure** and the **hypercycle**.

2853

REQUISITE HOLISM (Law of)

→ **Holism (Law of Requisite)**

2854

RESCUER^{1) - 5)}

A system (**exogenous**) or **subsystem** (**endogenous**) that helps a system to recover from some **disturbance** dangerous for its **survival**.

This concept has been introduced by L. SKYTTNER, inspired by the **survival** conditions at sea (1992, p.6).

He gives as examples: lifeboats, dinghies, communication equipment, **survival** equipment, ship surgeon, radio-officer.

A rescue (**sub**)system depends on the existence of **reserves** or **resources**, on a specific capacity to receive, decode and use **information**, through suited existing **channels**. It may be a part of the system, or possibly a separate system created to be able to rescue a member of "confederate" systems, when needed. An example of this last is the Red Cross.

→ **Allopoiesis**

2855

RESEARCH (2nd. Order)¹⁾²⁾³⁾

Second - order research is research on the research **process** itself. Its importance for the improvement of research **methodology** has been stressed by G.de ZEEUW, R. GLANVILLE and various members of the **Systeem Groep Nederland**.

In any type of research, **observation** implies unavoidably some kind of intervention. This is the case in micro-physics, as stated by HEISENBERG with his **Indeterminacy Principle**. But it is also true in psychotherapy for instance.

R. GLANVILLE writes: "We intervene in the (observable social) **object**. We change how it behaves by acting on it" and "We intervene in observing. We intervene both in how we observe and how we think of our observations (for instance, seeing observations as observables)" (2002, p. 110)

GLANVILLE adds: "We probably intervene in order to cope with unwanted **side effects**, **errors**, etc..., so we become more likely to get higher-quality observations" ... (Ibid)... and "The improvement lies in the conditions that lead to observations. Making observations of improvement gives new observables and new **observers**. We complete the chain: circulate; re-enter" (Ibid, p. 111)

D.P. DASH describes this process as follows: "In de ZEEUW's scholarly writings, research has been viewed as a developing **narrative**" (2002, p. 115). Research leads to "contact with greater and greater **variety of disturbances** and this creates a strain on the basic script on which the narrative of research in that field is based" (2002, p. 115)

In short, 2nd order research implies upgrading observation and research through observation of research itself. It is thus a cybernetic process based on recurrent **feedbacks**.

→ **Organizational closure; Problem solving; Underconceptualization**

2856

RESEARCH AND DEVELOPMENT¹⁾

The set of activities that tends to translate pure scientific knowledge into practical applications.

The aim of R&D is basically to create workable techniques out of general scientific principles. For instance, organic chemistry led to the production of many artificial derivatives of organic molecules, and genetics is now leading to genetic engineering.

R&D is however not much concerned with **side-effects** of its creations, because it is basically profit-oriented. In many cases - and more and more so - the **side-effects** are noxious or even catastrophic. Thus, from a systemic **viewpoint**, R&D should be re-framed in a more global perspective in order to forecast and take care in due time of possible negative effects.

2857

RESEARCH (Pre-systemic)^{1) - 3)}

I. BLAUBERG et al thus characterize pre-systemic research: "Investigation consisted mostly in 'decomposing' the **object** under study into **parts** and in their qualitative **description**, assuming that it was possible to construct a unique and exhaustive theoretical **model** of the **object** that would not depend on the problem being solved or on the methodological apparatus used" (1977, p.119).

In comparison with this method: "The **system approach**... proceeds from the fact that the specific features of an **object** (system) are not exhausted by the peculiarities of its constituent **elements**, but are rooted first and foremost in the character of the **connections** and **relations** between its **elements**. Moreover, a complex **object** is usually a hierarchical poly-structured and **multi-level** formation whose various aspects are studied by different sciences" (Ibid).

Two basic aspects of the **systemic methodology** thus appear: The need to avoid severing significant **connections** and the need for reciprocal **understanding** between disciplines by the use of suitable **models** of these **connections**.

2858

RESERVE^{1) - 2)}

Some quantity of **energy**, **matter** or **information** stored within a system, which could be eventually used.

The notion of **counter-aleatory** reserve has been introduced by P. VENDRYES (1942) who understands that the existence of adequate reserves is a sine qua non condition for the **autonomy** and even the **survival** of any **living** or **social system**, because no **regulator** has any counteracting power against **disturbances** if it does not dispose of ad hoc means.

This notion is somehow related to ASHBY's **law of requisite variety**.

As **regulators** act in order to maintain the internal **organization** of the system, it is also clear that the existence of internal reserves is a basic condition for **organizational closure** and **autonomy** in the sense proposed by H. MATURANA, admitting of course that the storing of the types of reserves proper to the system is itself conditioned by that same **autopoietic** property.

However, to store reserves, the system must to begin with, import them (and select them, and transform them), always in accordance with its (**autopoietic**) nature. The point is made by W.R. WINBURN, who writes: "The internal **structure** of the system determines its **representation** of the **change** such that we say that it is "**closed to information**". Yet the causal **process** behind this determination requires us to view the system as "**open to matter and energy**". **Energy** is imported and **dissipated**, but

also stored through internal **processes** (usually **metabolic**) defining a **negentropic** reserve. A sensed **change** may trigger this reserve into an extended release of **energy**, thereby producing complex **nonlinear behavior**" (1991, p.558).

2859

RESILIENCE^{2) - 4)}

The capacity of an adapting and/or evolving system to bounce back to **dynamic stability** after a **disturbance**.

In a more general meaning, resilience includes the system's ability to create new conditions of **fitness** for itself whenever necessary.

C.S. HOLLING describes resilience as: "... the ability of a system to maintain its **structure** and **patterns of behaviour** in the face of **disturbance**". He adds: "The size of the **stability domain** of residence, the strength of the repulsive forces at the **boundary**, and the resistance of the **domain** to contraction are all distinct measures of resilience" (1986).

He also observed: "Resilience determines the persistence of **relationships** within a system and is a measure of the ability of this system to absorb **changes** of state **variables**, driving **variables**, and **parameters**, and still persist. In this definition, resilience is the property of the system and persistence or probability of extinction is the result" (1976, p.83).

This condition is as well formulated by T.F.H. ALLEN and T.B. STARR: "The ability of a system to maintain its **structure** and general **patterns of behavior** when displaced from its **equilibrium condition**" (1982, p.276).

These authors add: "More resilient systems are those which can return to an **equilibrium condition** despite large displacement" (Ibid).

Resilience should thus not be confounded with **dynamic stability**, even if the latter is generally recovered as a result.

Resilience is in a trade-off relation with **stability**: *some limited instability* is a favourable **survival** condition.

Resilience may be greatly reduced or even suppressed when a system is driven too close to a **threshold of instability** by excessive pressure. This has been for instance frequently the case after overfishing of some marine or lake species: the **population may collapse irreversibly**, even if the excessive pressure is belatedly lifted.

However, within reasonable **limits**, as stated by W.D. GROSSMANN and K.E.F. WATT: "Systems will develop resilience and maintain it only if the **environment** of the system continually confronts the system with varying challenges. Resilience thus evolves in a way similar to human **immune capabilities**" (1992, p.16).

The same authors also state that: "... **complexity** is one prerequisite for resilience" (p.22).

In this way the notion of resilience is connected to ASHBY's **law of requisite variety**: no variety, no resilience... and no **viability**.

C. HOLLING states: "There are two resilience measures: Since resilience is concerned with probabilities of extinction, first, the overall area of the **domain of attraction** will in part determine whether **chance** shifts in **state variables** will move **trajectories** outside the **domain**. Second, the height of the lowest point of the **basin of attraction**... above **equilibrium** will be a measure of how much the forces have to be changed before all **trajectories** move to extinction of one or more of the **state variables**" (1976, p.86).

G. BROEKSTRA writes: "The new **fluctuation paradigm** views **organizations**... as instances of stable **chaos** or coherent spots of **vorticity** in a turbulent background... It implies the recognition that resilience rather than **stability** is crucial for the organizational **survival** and that resilience implies that the **organization** is generally far from its **equilibrium state**" (1992, p.1028).

As also noted by BROEKSTRA, "...all **fits** are only temporarily effective" (p.1029).

HOLLING has observed that there is a kind of trade-off between resilience and **productivity**. The latter can be increased, and even much increased, allowing for a loss of resilience, and conversely. At the **limit**, as stated by C. HOLLING and M. GOLDBERG, it becomes a matter of changing "...the emphasis from maximizing the **probability** of success to minimizing the chance of disaster. It shifts the concentration from the forces that lead to convergence on **equilibrium** to the forces that lead to **divergence** from a **boundary**. It shifts our interest from increased **efficiency** to the need for resilience" (1971).

2860

RESISTANCE (Acquired)¹⁾²⁾

An adaptive and evolutive **process** which allows a system to successfully fight the **effects** of some dangerous **input** from its **environment**.

Three very important examples are:

- acquired immunity of numerous pathological micro-organisms to a growing number of antibiotics
- progressive appearance of many new strains of insects able to resist the effects of numerous chemical insecticides.
- the progressive immunization of whole human **populations** against some infectious diseases. This seems to have been the case with plague in Europe from the 14th Century on. (However, such immunity may be lost after long **periods** without new **epidemics**).

Acquired resistance is a systemic **phenomenon** showing the shifting **equilibria** - through **adaptation** and **evolution** - in the **interrelations** of systems of different kinds.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The lack of understanding of acquired resistance becomes a critical deficiency in situations of accelerating **change** proper to our time of massive technological **evolution**.

An exploration of possible similar **phenomena** in societies could be interesting.

2861

RESOLUTION LEVEL ^{1) - 3)}

The level of discrimination used by an observer to study an **object** or a **concrete system**.

By means of appropriate instruments, for example various types of microscopes, an **observer** can obtain different resolution degrees, which could not be obtained by the use of his or her physiological senses only.

R. VALLÉE states: "Many of the **concepts** of the systems theory depend on the **observation process**" (1990, p.54), i. e. the resolution level, a notion emphasized by this author in his paper.

Many "**boundaries**" (for example, the skin of an animal) reveal themselves to be in fact complex **interfaces**, when the resolution level is improved.

Thus, models must be validated in accordance with the **space** and **time dimensions** of the samplings used to produce the basic **data**. There is always a danger of unwarranted interpolations or extrapolations, be it in **discrete (digital)** or **continuous (analogue)** models.

In any case "...no reality can be defined independently of an organization level" (R. PASET, 2000, P. 49)

→ **Level of resolution**

2862

RESONANCE ^{1) - 2)}

The **reinforcement** of a complex **effect** by the periodic coincidence of the different **periods** of the composing motions.

I. STEWART explains this as follows: "The combined motion repeats exactly if and only if the motions are resonant: there is some **period of time** that is an exact whole number multiple of each of the separate **periods**. Usually this doesn't happen" (1989, p.45).

When the respective **periods** are expressed by prime numbers (as for example 19, 91, 103 and 283) the exact whole number multiple becomes very great and the global periodic coincidence becomes practically unobservable, which does not necessarily mean that it does not exist.

I. PRIGOGINE states: "Resonance corresponds to the points where the ratio of **frequencies** is a rational number. Non-resonant points are points where this ratio is irrational" (1989, p.483).

Resonance may thus manifest **deterministic chaos** by combination of various movements of incommensurable **periods**.

As an example, resonance between asteroids and planets orbits may lead to orbital **instability** when the **configuration** brings the smaller body very close to the bigger one. This is for example the explanation of the perturbing influence of JUPITER on many asteroids and comets (C. MURRAY, 1989, p.61).

A dramatic example has been the destruction of the formerly periodic Levy-Shoemaker 9 comet in 1994, when swallowed by Jupiter.

According to E. JANTSCH resonance is as well basic in mental **phenomena**: "Between two static forms no exchange of **information** is possible in free **interaction**, but between two **metabolic** forms free **interaction** can have large qualitative effects. The topological product of two structurally stable systems is generally not structurally stable: the likely degeneration to a stable **field** leads to resonance" (1975, p.42).

In his study on the "Attentive Brain" S. GROSSBERG proposes a computational approach to resonance, based on the study of a **neural network**: "Adaptive Resonance Theory". He states: "In an ART **neural network**, **information** can flow from **short-term** to **long-term memory** during **learning** or from **long-term** to **short-term memory** during **recall**" (1995, p.440).

This may be the key for explaining the (more or less) **markovian** or **chaotic interrelations** between **short-** and **long-term processes** in general: **long-term** is constructed as an accumulative synthesis from **short-term** movements, but **short-term**, in the long run is submitted to **long-term limits**, representative of more general and permanent conditions.

2863

RESONANCE (Inductive) ²⁾

The synchronization of slightly out-of-step **oscillators** under mutual influence.

This curious effect was discovered by HUYGHENS in the 17th century (the spontaneous **synchronization** of two slightly out of phase clocks when fixed to a thin wooden board)

Inductive resonance is far from being limited to mechanical **oscillators**. As noted by LASZLO, it is related to "... the question of the **stabilization** around dynamically stable integral **configurations** in **complex systems**" (1974, p.217).

"It is found to occur in the **energy** transfer in photosynthesis between chlorophyll *a* and *b*, in the **synchronization** of the flashes of the fireflies, in the action of electronic pacemakers on the heart, in the adjustment of alphasrhythms to stroboscopic flashes perceived through the eye" (ibid).

2864

RESONANCE (STOCHASTIC)

→ **Stochastic resonance**

2865

RESOURCE MANAGEMENT ^{1) - 4)}

C. HOLLING states: "The **resilience** and **stability** viewpoints of the **behavior** of **ecosystems** can yield very different approaches to the management of resources. The **stability** view emphasizes the **equilibrium**, the maintenance of a predictable world, and the harvesting of nature's excess **production** with as little **fluctuation** as possible. The **resilience** view emphasizes **domains of attraction** and the need for persistence" (1976, p.87).

There is however a serious **criteria** problem with the definition of "nature's excess **production**". It is coming evermore obvious that our **lineal** view of natural systems is flawed and that our appreciation of global ecological **stability** is therefore quite dubious (when it exists !). As a result: "The very approach... that assures a stable maximum sustained **yield** of a renewable resource might so change these deterministic conditions that the **resilience** is lost or reduced, so that a **chance** and rare **event** that previously could be absorbed can trigger a sudden dramatic **change** and loss of the structural integrity of the system" (ibid).

Consequently, HOLLING proposes two complementary **strategies** for resources management: "The first would lead to the **design** of highly optimal systems in which **fluctuations** were minimized and explicit efforts were made to minimize the probability of failure – in short, a **fail-safe strategy**. There is absolutely nothing wrong with that if, accompanying that **strategy**, is an explicit ability to maintain a **stability region** of a **size** large enough to contain any unexpected **perturbation** the system might receive" (p.89-90).

However the unexpected is, by its nature, very difficult to define and predict. Moreover, human systems tend generally to maximize **growth** and resist any **regulation** until slowed down, blocked or even destroyed by the consequences of its own abuse, as shown by numerous historic examples.

In HOLLING's opinion, it is "almost inevitable that an attempt to reduce **fluctuations** would, at the same time, cause a shrinkage of the **stability** region through the action of cultural or natural **selection**" (ibid).

As a solution, HOLLING proposes a **safe-fail strategy**, that should "... optimizes a **cost** of failure and even assures that there are **periodic** "minifailures" to prevent evolution of **inflexibility**" (ibid).

As an example, let us capture periodically a lesser number of whales, in order to have still whales around in a more or less distant future... Or suffer frequent small tremors in order to avoid the great destructive earthquake.

→ "**Power laws**".

2866

RESOURCES¹⁾

Any type of **matter**, **energy** or **information** that the system may obtain from its **environment**.

Resources should not be confounded with **reserves**, which are resources already obtained by the system and stored within it for future use.

Environmental resources are not illimited, even if at times they seem to be. It is important for the systems which depend from them for their **survival**, to use them at a **sustainable rate**.

The competitive struggle for resources is a frequent occurrence and may be dangerous for the **survival** of some interested system.

In many cases however, such a struggle leads to the appearance of a **regulator**, which usually uses for itself a small part of the resources. This arrangement, once accepted or imposed, generally produces a settlement, favourable for all the participants.

A high **variety** of resources in an **environment** leads to much diversity of the systems that exploit them.

2867

RESPONSABILITY

→ **Rights and Responsibilities (Bill of)**

2868

RESPONSABILITY in systemic terms⁴⁾

Responsability makes sense only in **human systems**, i.e. for individuals in their multiple social **roles**.

However the systemic **approach** vastly modifies and amplifies the scope of the concept, as it modifies and amplifies our worldview. An example is the sense of ecological **responsability** which is starting to pervade ever vaster social **groups** and individuals. This is a result of our recent **awareness** of our growing power to impair **ecosystems** at any **level** through our careless or abusive **activities**... and to find ourselves victims of our own irresponsible **behavior**.

Another example is our new understanding of the ways so many **issues** and **situations** are becoming evermore complex due to growing and accelerating short and long distance **interactions** resulting from our enhanced means of action and long **distance** transport and **communication** capabilities.

At the same time the scope of our multiplied potential responsibilities is becoming more and more wide-ranging, it also becomes more diffuse. Most people remain unaware of many consequences of their activities, mainly because these do not become immediately and widely perceptible. Other people chose to ignore some of their responsibilities for personal interest reasons and in the belief that that will be able to escape scrutiny and punishment

of abuse whose results are not readily obvious (the so-called "tragedy of the **commons**"), or whose victims are unable to defend themselves.

What still generally lacks in our new situation is the **time dimension**. We have lost much of the trans-generational sense of responsibility proper to many archaic and traditional societies. Until now, the **long-term** view has generally not entered individual mentalities and the **evolutive acceleration** in our human systems **transformations** could easily overwhelm us.

True sense of responsibility must now also become systemic, in **space** and **time**. Already in 1979, Sir G. VICKERS, an outstanding systemist and former President of the ISSS, wrote: "Statements of human rights must be replaced by statements of human responsibility if we are to make the world viable" (1979, p.371)... Let us say, if not replaced, at least complemented with!

The most general nature and extension of human responsibility in individual and collective terms has been deeply researched recently by T. ECIMOVIC, M. MULEJ and collaborators, in their work " systems thinking and climate change", published at the University of Maribor, Slovenia (2002)

It could be said that personal responsibility must now include not only ethical one, but also a deeper and wider understanding of the general issues at stake.

→ **Right and Responsibilities (Bill of)**

2869

RESPONSE of a system¹⁾

"... a system **event** for which another **event** that occurs to the same system or to its **environment** is necessary but not sufficient" (R.L. ACKOFF, 1972).

ACKOFF states: "Thus a response is an **event** of which the system itself is a coproducer". He gives an example in order to distinguish a response from a simple **reaction**: "... a person's turning on a light when it gets dark is a response to darkness, but the light's going on when the switch is turned: a **reaction**" (Ibid).

2870

RETENTION

→ **Hippocampus; Object-in-time**

2871

RETRODICTIVE ILLUSION (The)³⁾

It seems always possible to retrospectively "predict" some **event** that occurred. This implies the *a posteriori* reconstruction of a deterministic chain of successive **events** which led to the most recent one.

The concurrence of multiple causal **events** at the ultimate instant induces the illusion that the **event** had one cause only, that this cause in turn had one cause only, and so on in a ret-

rodictive way. This is of course the result of a **selection** made by the **observer** and goes long to explain many heated debates and even lawsuits centered on "responsibility for..." such or such **situation**.

However true **causality** is complex, as the result of growing interferences between numerous more or less simultaneous or successive local **events**.

The retrodictive illusion leads to the rigorously causal predictive illusion, which, during much time did conceal **deterministic chaos**.

2872

RETRO-PROPAGATION APPROACH²⁾

The calculation of the quickest and most efficient **path** backward, from the **goal** to the actual **configuration** (C. HARDY, 2001, p. 49)

This author writes: "...whenever the final **state** of a system, or the solution to a problem, is known in advance, but the intermediate steps remain unknown, it is appropriate to use a **procedure** in which current **events** are guided by future outcomes" (Ibid)

Future planified outcomes install in fact a **feedforward**.

Hardy adds: "Some **neural nets**, for example, operate by retro-**propagation**, comparing, at each step, the current state with the final one, looking for the shortest route from the desired final state to the current one" (Ibid)

The retro-propagation approach leads to impressive success in chess-playing by computer.

→ **Epigenesis; Parallel distributed processing**

2873

REVALIDATION (Cybernetic cycle of)¹⁾²⁾

In his well known lecture "The surrogate world we manage", St. BEER explained why and how our **model** of any factual **situation** or **issue** must be constantly (or at least frequently) revalidated (1973)

Modeling should be ideally a dynamic ongoing **process**, at least for five reasons:

1- our **perceptions** of anything in the world outside ourselves (and even inside!) are always partialized, as our senses are such imperfect perceptive devices (even when aided by instruments)

2- our model construction is subjective by nature and depends on our acquired **frames of references** and their more or less frequently verified relative validity

3- we tend to confuse our model with the **objective/reality** (as we understand it)

4- after a **time lapse**- that can be long or short- the external situation has probably changed, and sometimes very much so

5- when we make **decisions** for **action**, apply them to the perceived issue or situation and the results are unsatisfactory, we tend to cling

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

to our model, whatever the **cost**, and thus introduce our own **evaluation** problem as one more factor of **disturbance**

Consequently we should revise and recycle our models in a cybernetic way, considering registered external **changes** and the results of our own interventions as recurrent **feedbacks**
→ **Decision making; Program; Strategy**

2874

REVERSIBILITY ^{1) - 3)}

The character of a **process** whose direction of **change** can be reversed by a suitable alteration, *however small*, of the (generalized) force applied to produce the **change**. (Adapted from A. LOTKA, 1956, p.23)

Reversibility is a purely abstract concept. The direction of **change** can be reversed... but only through an irreversible movement from a former to a later **state**.

In real **processes**, any **action** causes some **dissipation of energy**, *however small*, i.e. "its conversion into heat at the temperature of the surroundings" (Ibid). Thus the **2d law of thermodynamics** is the impassable barrier against reversibility, as stated for instance by F. HEYLIGHEN: "Reversibility is equivalent to the non-increase of **entropy** (i.e. the non-decrease of **information**)" (1989, p.369).

Moreover, any **process of change**, even a reversal one, supposes a **lag in time**, which also is in accordance with the **2d law**.

2875

REWARD ¹⁾

A positive return obtained by a system through some adequate **action**.

The search for reward necessarily implies **relevance criteria** about what should be defined as a reward. Such **criteria** would be based on results of former experiences (not necessarily always a perfect source of **decision-making**).

According to G. PASK there is "a basic **distinction** between reward, as used in **computer programme** to mean that a rewarded **event** becomes more probable, and reward as it used in a system able to create fresh **components** and **parts** of itself. In this latter case, reward means ability to develop, ability to expand, and ability to become **stable** by becoming a larger system" (Quoted by P. CARIANI, 1993, p.25).

In any case, in the definition, "adequate" sounds somewhat tautological... and anthropomorphic. Moreover, many human systems seek "positive" rewards, and obtain them. But there is generally no guaranty that **short term** rewards would not exact some unknown back pay later on.

2876

REWARD LOOP ²⁾

A **positive feedback** emitted by a downstream system which favors an upstream system from which it thus gains an increase of useful **inputs**.

H.T. ODUM explains this in the following terms: "In ecological studies there is the **positive feedback loop** through which a downstream recipient of potential **energy** rewards its **source** by passing necessary materials back to it. For example, the animals in a balanced system feed back to the plants in reward loops the phosphate, nitrates, and other compounds required for their **growth**... Species whose work efforts are not reinforced are shortly eliminated, for they run out of either raw materials or **energy**. They must be connected to **input** and **output flows** to survive" (1971, p.150)

Reward loops act as **selectors**. This conceptual frame, as noted by ODUM, can be readily applied to economics, where "... money provides a means for organizing **energy flows**" (p.174-177). As suggested by K. BOULDING, "**ecosystem**" seems an equally suitable name for ecological and economic systems... and even possibly for their unavoidable **integration**.

2877

REWRITING ²⁾

An **algorithmic process** based on a **recursive rule** for the application of some of its **rules**.

Rewriting in **algorithms** tends to produce repetitive and **self-similar forms**, frequently in **fractal form**. The rewriting conditions can be differentially adapted in order to create more realistic **models** of natural **forms**.

→ **Growth algorithm**

2878

RHEOMODE ³⁾

A mode of thinking and of using **language** that underscores a world view in which "... all is an unbroken and undivided movement and ... each "thing" is abstracted only as a relatively invariant side or aspect of this movement" (D. BOHM, 1980, p.47)

D. BOHM, who proposed this neologism, states that this new mode "... can help to draw our attention to the way in which our ordinary **language-structure** puts strong and subtle pressures on us to hold a fragmentary world view" (Ibid).

BOHM observes that our present **language-structure** is "... dominated by the divisive form of **subject-verb-object**... (which) tends continually to lead to fragmentation" (Ibid, p.31).

As we are generally not conscious of this ingrained bias, our whole way of forming concepts and models becomes unilaterally distorted.

BOHM does not give many factual indications for acquiring the art of such rheomodal **language**, but A. KORZYBSKI, in "Science and Sanity" offered numerous psychological tricks to practice it (under the different label of **non-aristotelician language**) (1933, 1950).

2879

RHYTHM ^{1) - 2)}

A **pattern** of movement, characterized by the **recurrence** at a regular **frequency** of some pulse in a **process** or system.

Rhythms are ebbs and rises in periodic **phenomena**.

They are generally a **synchronic response** (in **phase** or out of **phase**) to some other rhythm at a more embracing **level**. They can be simple or complex and are observable on the whole scale of **phenomena**, from nuclear physics to cosmic ones. They are also present in ecology, economy and in social **evolution**.

They should thus be considered as a general family of **isomorphic** features in systems.

Rhythms are present, for instance, in climates (and all biological and economic activities under their dependence: for ex. **circadian rhythms**), in oceanic tides, in light and sound and generally electromagnetic waves; in **populations ecology**; in physiological activities (from heartbeats to vegetal **growth**) and quite possibly in **history**.

C.A. BOGDANSKI has produced an interesting list of correspondences between physical or biochemical rhythms and physiological ones (1969, p.113).

There is a great **variety** of rhythms, corresponding to **oscillations** of **short, medium** and **long periods** or **frequencies**; and also to specific systemic and **subsystemic processes**.

2880

RHYTHM (Circadian)→ **Circadian Rhythm**

2881

RIGHTS and RESPONSABILITIES (Bill of) ⁴⁾

G. and E. PINCHOT proposed a "Bill of Right and Responsibilities of the Intelligent **Organization**" (1993, p.364-5) in which every right is balanced with a corresponding responsibility. For example, freedom of **inquiry**, as a basic condition for freedom of **learning**, is balanced by the responsibility to be "curious, persistent and aware"; or freedom of **association** is balanced by the responsibility to "make commitments wisely"; or freedom of speech is paired with the responsibility to "tell the **truth**, the whole truth and nothing but the truth".

All this amounts to the establishment of better psychosocial **regulations** in **human systems**, as so many people are – or feign to be – unaware of the impossibility to maintain systems which would produce only **outputs**.

G. DYER is now spreading this "Bill of Rights and Responsibilities" for orientation of the general **behavior** of people within the **groups, organizations and societies** in which they participate, and most specially in **design groups** (1996, p.52-53).

He has described a number of complementary **behaviors** such as the right of one individual is guaranteed by his/her the admission of a complementary responsibility from his/her part. Here are some examples:

The right to "freedom to communicate one's views without fear" must be balanced by the responsibility to "not dominate **conversation time**". Or the "right to take individual **decisions**" should be complemented by "recognizing the possible consequences of individual **decisions** and face them up if required".

The proposal amounts to the introduction in human affairs of psycho-social **regulations rooted within the individuals** and should lead to better equilibrated, more productive and less damaging activities in any human group.

It amounts thus to a practical psycho-cybernetic device.

2882

RIGIDITY¹⁾

State of a system whose **stability** may be endangered by even small **changes**.

While an excess of rigidity is dangerous, a minimum of it is nevertheless necessary in order to maintain the systems **coherence**.

Rigidity in systems increases generally with **time**. It is expressed by a progressive decrease of the ability to fluctuate between the **limits of stability** and, quite frequently, by a shrinking of these **limits**. One may also interpret it as a decrease of **variety**, in the sense given to it by ASHBY, obviously going with a lessened capacity to adapt to the **variations** in **environments**.

2883

RING

→ **Connection modes**

2884

RISK ANALYSIS¹⁾

That part of the **decision process** that tries to evaluate the probabilities of negative outcomes of possible alternative courses to be taken.

Risk analysis is as necessary as it is difficult. Any **decision** introduces new conditions that modify the global **situation** in ways difficult to forecast.

Possible systemic tools for risk analysis are **scenarios**, complex **cyclical models**, **systems dynamics**, and even **chaos theory**. None however can give any absolute certainty.

2885

RISK MAKERS¹⁾⁴⁾

"**Decision** makers whose **decisions** make risk for others, but not necessarily for themselves" (M.H. GLANTZ, p.12)

GLANTZ applies the concept to the case of the Moscow bureaucrats who took the **decisions** that led to the drying of most of the Aral Sea.

He adds: "The bottom line is that risk makers are often not held accountable for the **environmental crises** that result from their **decisions**" (Ibid).

Two more aspects should be emphasized:

1. Leaving apart the (frequent) case of risk makers who quite consciously take **decisions** in benefit of some pressure **group**, many are basically victims of their ignorance of **synergic effects**. Such ignorance generally results of their narrow specialized angle and incapacity of appreciating **cross impacts** with other **issues**.

2. Risk makers are also indifferent to the possible **long-term effects** of their **decisions**, and ignorant of any sound **prospective methodology**.

In any case, paraphrasing Lord KEYNES, in the long run, we will all be dead. This is indeed a powerful incentive to irresponsibility.

2886

RISK SHARING⁴⁾

A collective and cooperative **behavior** in a social group aiming at mutual protection.

The behavior can be observed in many social animals.

Examples are joint heat production or fanning in beehives, reciprocal protection by **swarming** against predators in fish **schools**, or heat sharing by huddling in emperor penguins in the Antarctic.

And it is of course in human **groups** that risk sharing becomes a very general and fundamental behavior in a great variety of ways. P. CORNING considers sharing activities of all kinds as a typical **emergence phenomenon** produced and expressed through **synergies** which are in his view a "pan-disciplinary phenomenon" (1998a and b)

→ **Herd effects**

2887

RISK (SYSTEMIC) in human issues⁴⁾

The possible appearance of **states** in which the individuals rational or irrational **reactions** to the risk as it is perceived, increases the **instability** of the system instead of reducing it.

This happens for example in markets and leads to panics and crashes. This **phenomenon** is related to **runaway processes** wherein **positive feedbacks** lead to explosions or **collapses**.

2888

RITUAL⁴⁾

A spontaneous **mechanism** of social **control** characterized by non-rational **behavior** uncritically adopted by the members of the **society**.

A ritual is a behavioral **template**, obviously of evolutive origin. It operates a socially and transgenerational **recursive** pre-conditioned conditioning based on a **set** of mostly gestual **communication devices** (in fact a **language** in a very general sense). It is **representational** and tends to standardize **learning** and use of basic **behaviors**.

Rituals seem to have their roots in some animal **behavior** like nuptial parades, territory marking and danger signalling. In human societies, they become masses manifestations, generally religious or ideological. They strongly inhibit individual **behavior** and, by reinforcing adhesion to common beliefs, **values** and **norms**, focalizes mass **action**. Consequences can be either positive, or negative.

→ **Consensus; Culture; Imitation; Meme; Memetics; Schema**

2889

ROBOT¹⁾

A **machine** or device that works automatically or by remote **control**.

The term is originally czech and derives from the slavonic root that means "work"

The humanoid robot is mostly a science-fiction fantasy. However **robotics** is an increasingly diversified research subject with industrial applications and wide theoretical extensions.

2890

ROBOT (KHEPERA)¹⁾²⁾⁵⁾

A robot constructed at the Lausanne Federal Polytechnic School by D. Floreano and his team (2002, p. 24-28) (2002-03, p. 40-52)

This robot is adaptable, i.e. able to modify its **behavior** according to its **perceptions**

It is now used to study what the FLOREANO team calls "**artificial evolution**".

This team is also researching the "predator-prey" **interactions** using two robots, whose behavior is evolving and becoming more and more complex.

These studies are also renewing the **co-evolution models**.

→ **Animat; Artificial Life; Fitness function; Neural networks; Parallel distributed processing; Weights (Synaptic)**

2891

ROBOTICS⁵⁾

The science that studies electronically commanded devices (called robots) able to autonomously perform tasks, and the techniques that allow to construct such devices.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

In a more abstract way, it has been defined as "the intelligent **interconnection** between **perception** and **action**" (E. BUCHBERGER, 1987, p.70). This author states: "Robotics is concerned by all aspects of construction and use of robots, as for example **regulation** techniques, sensorics, tasks **planning** and **knowledge representation**" (Ibid).

The term "robot" comes from the Czech "robota", meaning heavy labor and was introduced by the Czech novelist K. CAPEK.

Two widespread tendencies- one informal, the other formal- have influenced, and possibly hindered, the advance of robotics. The informal one is the popular interest in humanoid robots, which derives from a historically quite old mechanistic **model** of **automata** (VAUCANSON's duck, the "turkish" chess player...and even Dr. Frankenstein's wretched creature)

The formal model has been transposed from computer programmed **artificial intelligence**.

As to the old Jewish Golem, it is neither a **mechanism**, nor a computer ghost. In fact, it is the actor of a significant philosophical story, even if it nourishes popular fantasy.

Robotics has now escaped from these dead ends. It is however still too early to know where so-called **artificial life**, as a **bottom up self-organizing** range of interacting **rules** and **processes** could lead us.

→ **Algorithm; Heuristics; Perceptron**

2892

ROBOTICS (Evolutionary) ¹⁾⁵⁾

The study of individual **adaptation** and species **evolution** through the **observation** of **robots** equipped with so-called **neural networks** made of interconnected electronic **components** able to modify their **interrelations** and **global behavior**

2893

ROBOTS (Social) ^{4) - 5)}

Groups of **artificial organisms** able to develop a coordinated **behavior**.

Such **groups** are showing what is now called **swarm intelligence**, as can be observed in ants or bees... and **human societies**.

Various **Artificial Intelligence** laboratories in the world are presently experimenting with **self-organizing groups** of robots: at M.I.T. (R. BROOKS and P. MAES), at Brussels Free University (L. STEELS), at ONERA and Paris VI University (J. ERCEAU and J. FERBER).

This research in so-called "**artificial life**" is at least partly inspired in insect societies. It seems promised to a considerable technical future (for example in extra-terrestrial exploration). It is however probably even more important in relation to our **knowledge** of the general systemic nature of **sociality**.

As an example L. STEELS, quoted by S. LEVY (1992, p.302), constructed "a robot **ecology**" based on functional **self-organization**... drawing from the social insects and **cellular automata** studies of his neighbors at the University of Brussels, studying under PRIGOGINE, and postulating robots running under BROOKS's **subsumption** architecture".

The subject is also related to **emergence** through **dissipative structuration processes** affecting, in this case, groups of numerous interacting **elements**. (See for instance P.M. ALLEN, 1980 and 1982).

2894

ROBUSTNESS ¹⁾²⁾

Generally, the quality of a device- or by extension, a system; **network** or **automaton** able to resist even important **disturbances**, or the loss of some **elements**.

Robustness is obtained mainly in two ways:

- 1- by the presence of a number of duplicate elements which can replace the disabled ones
- 2- by the high **variety** of the possible **couplings** between two, or more elements

A frequent condition for robustness is the existence of **redundancy** in the system

→ **Automata (Reliability of); Automata network; Hologram; Network; Redundancy in networks; Reliability**

2895

ROLE ⁴⁾

The specific **behavioral repertory** of differentiated individuals in a **social system**.

Roles are constructed through **conditioning**, **training** and **learning** within the individuals. This **process** is transgenerational and is needed to maintain the continuity through **time** of the **social system (time-binding)**.

Any society needs a variety of different roles in order to fulfill the various **functions** needed for its **survival**. In very complex **human systems**, roles become evermore differentiated.

Any individual or **element** has generally a **variety** of roles in her/his/its society or system, each one related to some specific **situation** or circumstances. As observed by F.K. BERRIEN, "role **behavior**" (**output**), is generally "a **response** to the role expectations by others (their **outputs** serving as **inputs** to the behavior)" (1968, p.106).

Roles can be modified even in insect societies (see: **Sociotomy**). In **human systems**, the **repertory** itself, that corresponds with a specific role, can be modified in an adaptive way. Moreover, any individual adopts normally a succession of different roles during her/his/its lifetime.

2896

ROOT DEFINITION ¹⁾²⁾

"A concise, tightly constructed **description** of a **human activity system** which states what the system is" (R. RODRIGUEZ ULLOA, 1999)

"What it does is then elaborated in a conceptual **model** which is built on the basis of the definition. Every **element** in the definition must be reflected in the **model** derived from it. A well formulated root definition will make explicit each of the **CATWOE elements**. A completely general root definition embodying **CATWOE** might take the following form:

"A (...O...)-owned system which, under the following environmental **constraints** which it takes as given (...E...) transforms this **input** (...) into that **output** (...) by means of the following major **activities**, among others: (...), the **transformation** being carried out by these **actors**: (...A...) and directly affecting the following beneficiaries and/or victims (...C...). The world-image which makes this **transformation** meaningful contains at least the following **elements** among others: (...W...)"

"A root definition describes a notional system chosen for its **relevance** to what the investigator and/or the people in the problem **situation** perceive as matters of contention" (Ibid).

2897

ROUTINE ²⁾

A fixed **set** of instructions in a **program**, that can be used everytime in similar **situations**.

H. SIMON explains: "Any **module** (or routine) in a well structured **program**, can be characterized by the **inputs** it needs, the **outputs** it produces and the **transformations** it operates on the **inputs**. The internal **language** used in such a **module**, its way to operate the **transformations** are not significant for its characterization. Thus any other **module** in the system may call on a given **module** without any need to know its internal **structure**; the whole **communication** between **modules** is channeled through their **inputs-outputs**" (1990, p.141 - retranslated from French!).

It seems thus that routines are necessarily **algorithmic**.

2898

ROUTINES (Ecology of) ^{2) - 4)}

The relations among "various procedures (that) mutually support each other and form a more or less coherent **pattern** of "standard operating procedures" (A. HAUAN et al., 1992, p.1061).

According to A. HAUAN, J.A. JOHANNESSEN and J. OLAISEN, who introduced the concept: "The overall functioning of an **organization**... is to a large extent dependent on the qualities of the collective-level routines".

As various participants are bearers of different routines, the authors add: "**Heterogeneous groups** are preferred to **homogeneous groups**, to enhance **complementarity** and avoid standardisation, fragmentation and segmenting of **patterns** of thought and **behavior**".

The concept seems to be an application to social **organization** of BATESON's ideas.

2899

r-STRATEGY²⁾

A strategy resorting to the use of "a large number of low **energy organisms** whose short **life span** is compensated for by a very high rate of reproduction" (R.N. ADAMS, 1988, p.134).

This strategy, based on quick replacement, is opposite to the K-strategy. It is convenient in turbulent conditions, with a high rate of **disturbances**.

According to ADAMS: "Nonhierarchical organizations are more like the r-strategy". Moreover: "r-type **organizations** can fragment and still retain their capacity to survive in refugee areas" (ibid).

The concept has been applied in ecology by R. MARGALEF and seems significant for, at least, small **human systems**.

2900

RULE^{1) - 2)}

"A set of **constraints** which are local, arbitrary, **structure**-dependent, and associated with **rate**-independent aspects of **control**" (T.F.H. ALLEN & T.B. STARR, 1982, p.276).

A fine example are the rules of chess.

H. PATTEE (quoted by ALLEN & STARR, p.42) writes: "The basic **distinction** between **laws** (Note: i.e. so-called "Laws of nature") and rules can be made by these **criteria**: **laws** are a) inexorable, b) incorporeal, and c) universal; rules are a) arbitrary, b) **structure** dependent, c) local. In other words, we can never alter or evade **laws** of nature, we can always evade and change rules. **Laws** of nature do not need embodiments of **structure** to execute them; rules must have a real physical **structure** or **constraint** if they are to be executed" (PATTEE, 1978). In this sense, legal codes are in fact systems of **rules**.

PATTEE's concept of laws is quite platonian: we can discover them only by seeking common features to a number of rules relatives to "real physical **structures** or **constraints**" proper to **concrete systems**.

One could say either that the laws are immanent in systems, or results from their pre-organized "reading" by the **observer**. In this way K. KRIPPENDORFF states: "The search for rules rather than laws distinguishes two schools in **communication** research, the **cybernetics** of observing systems from the **cybernetics** of observed systems and perhaps the social sciences from the natural sciences" (1986, p.67).

J. CASTI, possibly wandering on the border between laws and rules, writes: "Scientific rules are **objective** in that they are relatively free of investigator bias... For example, the exponent in NEWTON's inverse square law of gravitation is 2 and not 2,315 of 17 or any other number besides 2... In short, the rule is **observer-invariant**" (1994, p.13). While this is somehow contradictory with the definition and PATTEE's opinion, it softens somewhat **ontological skepticism** and is a counter-weight to a tendency to **solipsism** that seems sometimes to threaten **autopoietic** approaches.

Rules are *generative*, i.e. they **constrain** the **set** of possible combinations of **elements** in a specific way.

Rules are either introduced through a **program**, or indirectly constructed in an automatic way.

2901

RULE DISCOVERY²⁾

"The replacement of rules of low strength by new rules when environmental **situations** are ill-handled" (J. HOLLAND, 1992 p.176)

This **process** is proper to evolving adaptive **rules-based systems**. It uses **recombination**.

It leads to "generating plausible replacements for rules assigned low strength" (ibid, p.179), through a credit assignment **algorithm**, and is the motor of **adaptation** in systems of this type.

→ **Back propagation algorithm; Evaluator; Pattern recognition**.

2902

RULE (If - then)²⁾

Any rule that establishes the conditions of a specific **behavior**, or various alternative ones.

M. BODEN states: "A rule may include several conditions in its IF-side and several **actions** in its Then-side" (1990, p.215). Commenting on an abstract drawing program (AARON), she states: "Abstract-AARON's If-Then rules may be fairly complex. Several aspects (not just one) of the current state of the drawing may have to be checked, before the **program** knows what to do next" (p.143).

If - then rules are used in what A.I. workers call "production systems", notably **expert systems**. BODEN gives the example of an **expert system** for the detection of soybeans diseases, which includes an array of descriptors of various types: environmental ones; global plant ones; conditions of leafs, of stems, of fruit pods, of seeds and of roots. (p.184).

MARUYAMA's **deviation-amplification processes** in **cybernetics** are also based on If-then rules.

2903

RULE (Meta-)²⁾

A rule defining in which way rules should be applied (E. BUCHBERGER, 1987, p.31).

A meta-rule is on a higher **level** of **abstraction** than the rules it controls. Its characteristics depend however of the nature of the *possible interactions* between subordinated rules. This feature is present in any **hierarchically complex system**, as well as in RUSSELL's and WHITEHEAD's **theory of logical types**.

2904

RULE (Recursive)²⁾

A rule applied in a repetitive way, generally in accordance with other rules.

R. SOKAL has shown that recursive rules can generate quite complex **patterns**, particularly when applied in connection with other rules (1968).

Other **models** in which recursive rules are a basic feature are M. MARUYAMA's **deviation-amplification processes** and J. CONWAY's **games of life**.

2905

RULE (Rewrite)^{2) - 5)}

"A rule which apply to a string of characters and replace some of those by another string" (KRIPPENDORFF, 1986, p.66)

The concept comes from CHOMSKY's **linguistics**.

It is however a quite more general feature, as being applicable to recoding any stretch in any **code**.

2906

RULE-BOUND HUMAN SYSTEMS⁴⁾

P.A. BALLONOFF enounced a "Theory of Rule-bound Human Systems"(1994, p. 837-860), whose main features are as follows.

Human systems are generally **rule-bound**, because they could not maintain themselves otherwise.

They create their own rules and when these rules stabilize, they become codified (by custom, or law) and turn imperative for the **behavior** of the various social **groups** and their members.

As stated by BALLONOFF, the system has become "rule-bounded" and the rules affect "human **choices** and **actions**".

While the author only alludes sketchily to the fact, in many cases people try to escape from the rules and parallel rules systems appear (as for ex. barter, fraud and smuggling rings, mafia, monopolies). Rule-bound systems may crash if they become inefficient. BALLONOFF shows that rule-boundedness in human systems is prac-

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

tically universal. The French anthropologist C. LEVI-STRAUSS, for ex. described archaic groups which are rule-bound in his "Elementary structures of kinship"(1949)

BALLONOFF exposes in his paper a formal theory of rule-bound human systems, which is useful in order to avoid implicit (or even explicit!) contradictions between rules, specially when transformed into **laws** and **regulations**. This becomes very significant at the constitutional level.

Models of rule-bound systems have practical value for prescriptions of policy, for **anticipation** and **forecasting**.

Moreover specific types of rules apply to specific types of systems. For ex. rules relative to monopolies or oligopolies may be different in small or large economic systems.

Finally BALLONOFF discusses the **evolution** of rule-bound systems in general (p.850-2) and shows that, while for ex. insects societies whose rules are "coded by biochemistry" and are "very, very stable", contemporary human systems rules turn much less permanently settled and , consequently "explicit rules for how to change the rules" are needed.

→ **Evolution; Free-will; Logic and Culture; Operator (Decision; Observation; Pragmatic); Stigmergy**

2907

RULE-obeying transition

→ **Transition (Rule-obeying)**

2908

RULES BASED SYSTEMS^{1) - 2)}

Any system is by necessity of **coherence** somehow rules- based.

However, there are seemingly at least two different kinds of rules-bases. The first type is supposed to determine strictly the **behavior** of the system. In A. PREM's words: "Completeness of rules-based systems means the requirement that there is a rule for each possible **situation** and that the given **set** of rules correctly solves the problem" (1992, p.1344). In such cases the **set** of rules is an pre-constructed and rigorously invariable **algorithm**. This is the general case of **mechanisms** and can be extended with some measure of success only to a limited number of non-mechanical systems as for example chess (as observed by PREM).

Systems based on this **class** of rules have practically no fault **tolerance**: "One single missing, inadequate or damaged rule may stop the whole **inference process**" (ibid. p.1345).

However **connectionism** offers us an alternative: **networks** of rules whose multiple possibilities of **interactions** are so highly **redundant** that the potential combinations are practi-

cally infinite in relation to the probable span of existence of the system. Such **networks** are able to construct specific or specialized **algorithms** to some particular ends without exhausting their capacity to produce new ones. Systems thus equipped are relatively able to adapt themselves to new **contexts** and to learn new **behaviors**.

In W. Mc CULLOCH words a rule of this kind is "... a **message** that could be written many places and read out differently in different **context**" (1974, p.8).

The point is also made by St. KAUFFMAN (1993, p.394), who observes that rules can be mutually **triggered** and even "**coevolve** with other rules by mutation, recombination, and **selection**", in biological systems or in **problem-solving computer algorithms**, as stated by J.H. HOLLAND.

2909

RULES (Generative)²⁾

Interacting rules endowed with the potential to develop **complex systems** when applied to some initial group of **elements**.

Such rules, through a prescribed way to combine some type of **elements**, leads to the production of new **elements** and combinations of these elements. The MENDELEIEV periodic table of elements is based on a complex **set** of induced generative rules.

The problem of generating rules has been investigated by various authors, from von NEUMANN and TURING on. M. MARUYAMA studied it in a often quoted article (1963).

The following aspects seem important:

1. Construction rules are framing **algorithms**, whose potentialities are only partially revealed by environmental conditions: in another **environment** they could produce a different **structure**.
2. The original **order** of the **elements** exerts a determining influence on the way the rules will act. They have a **positional value** and, in real systems, specific characteristics, as for example in the case of genes.
3. In MARUYAMA's words: "When the rules are unknown, the amount of **information** needed to discover the rules is much greater than the amount of **information** needed to describe them" (p.168). This is another way to express that the **set** of rules constitutes an **algorithm**.

Generative rules, when complex and not over-constraining, can produce a practically infinite **variety**, as for example genetic **codes**, chess rules or, in music, classical harmony as well as dodecaphonic rules. (M. BODEN, 1990, p.38-40).

2910

RUNAWAY EVENT^{1) - 2)}

A giant **fluctuation** in a **composite system**.

Examples of this type of events are catastrophic earthquakes, snow and ice **avalanches**, **population pandemics** or stock market crashes.

Runaway events are unfrequent and quite difficult to predict.

Composite systems are generally **chaotic** and thus **deterministic** only in a very global sense, while subject to **random-like behavior** in time.

In P. BAK and K. CHEN terms: "In **chaotic systems** a small initial **uncertainty** grows exponentially with **time**. Furthermore, as one attempts to make **predictions**, further and further in the future, the amount of **information** one needs to gather about the **initial conditions** increases exponentially. For the most part, this exponential **growth** prevents **long-term predictions**"(1991, p.32).

A runaway event generally leads to a **catastrophe discontinuity**.

→ **Power laws**

2911

RUNAWAY PROCESS^{1) - 2)}

An irreversible **processs** through which a system is forced through an **instability threshold**.

Such a process implies the swift loss of **dynamic stability** and may lead either to the destruction of the system (f. ex. **growth** of a cancer), or to **dissipative structuration** and **emergence** of a higher **level of complexity**.

A runaway results from the **action** of an uncontrolled **positive feedback**. J. MILSUM observes: "... upper and lower **constraints** always exist in real systems which prevent true runaway, and may even mask the positive-loop nature of some systems when operating within these **constraints**" (1968, p.39).

As recorded by MILSUM, these **constraints** appear as "floors" and "ceilings" in BOULDING's terminology.

As also noted by MILSUM, **stable** systems avoid runaways by combining positive and negative **loops** (in this encyclopedia: **compensated feedbacks**).

Runaway **processes** are generally destructive, as for example in a fire. They may also lead to **bifurcations**, or "**catastrophes**" in R. THOM's sense, or to a higher **level of stability**, when triggering **dissipative structuration**, as viewed by PRIGOGINE's **thermodynamics**.

The many times used **metaphor** about "**snowball effects**" corresponds to runaway processes.

S

2912

SADDLE²⁾

A general converging point in a three dimensional **chaotic attractor**.

The saddle is formed by two overlapping **fractal structures**, the inset and the outset of an unstable solution.

The central point C of the saddle is common to the stable **manifold** of the system and to its unstable one.

As the saddle implies **convergence**, it is easier to stabilize a **chaotic system** by application of small corrections (or **perturbations**) when the chaotic **trajectory** passes near its central point (D. BROOMHEAD, 1990, p.23).

St. KAUFFMAN writes: "... saddle **steady states** are stable with respect to **perturbations** in some directions, and unstable with respect to **perturbations** in other directions. The existence of saddles reflects the fact that two **stable basins of attraction** must abut, and the ridge where they do is a **basin of attraction** having one fewer dimension than the number of **variables** in the system and is called a **separatrix**" (1993, p.177).

2913

SAINT MATTHEW PRINCIPLE (MARGALEF)^{1) - 2) - 4)}

"For whosoever hath not, from him shall be taken away even that he has" (Matt. 13.12)

(Also known as Saint Mark Principle, 4.25)

This New Testament quote, remembered by R. MARGALEF, has been translated by him in terms of an ecological principle as follows: "When two systems interact, **information** increases relatively more in that one which is already more **complex**, as it seems to feed from the more simple and may assimilate it" (1980, p.28).

Or "The system bigger in terms of acquired **information** is always able to make better use of **information**; that is to say to assimilate and multiply it" (p.27).

MARGALEF considers this principle as "... extraordinarily valuable in **ecology** as well as in **General Theory of Systems**. It could contribute to sharpen the **gradients** of any property that may be interpreted as an **information carrier**" (Ibid).

Indeed, the principle accounts for the progressive evolutive build-up of more **complex systems**, by **integration** of simpler ones: Industrial take-over and absorption of archaic tribes by bigger human groups are examples.

→ SIMON's Hora and Tempus Parable.

2914

SANTA FE INSTITUTE¹⁾

P. BAK writes: "The Santa Fe Institute in New Mexico is a lively center for exchange and debate on **complex systems**...

"The Institute brings together many of the most imaginative thinkers from vastly different fields in an open **environment**. The meetings at Santa Fe are continuous **brain storms**" (1996, p.114)

He adds: "Since the Santa Fe Institute does not have a permanent staff of scientists, it can change its emphasis quickly when new ideas come up. A number of external professors are associated with the Institute... In contrast, traditional university and government laboratory **environments** have a tendency to freeze into permanent **patterns** as their scientists become older. Typically, a couple of long-term visitors, some short-term visitors, and a few young postdoctorate fellows work at the Institute. In addition, scientists from various fields come together at seminars and conferences"...

"These meetings force us to place science in a greater perspective. In our everyday research, we tend to view our own **field** as the center of the world. This view is strengthened by our peer groups, which are, because of the compartmentalization of science, working along the same lines. No mechanism for changing directions exists, so more and more efforts go into more and more esoteric aspects of well-studied areas that once paid off... Nobody has an incentive to step back and ask himself, "Why am I doing this?" In fact, many scientists are put off if you ask this question" (p.115-6)

2915

SANTIAGO THEORY¹⁾³⁾⁴⁾

"A system theory of **cognition**, developed by H. MATURANA and F. VARELA" (F. CAPRA, 1997, p. 174)

Santiago is for Santiago de Chile, as both authors are Chileans.

Santiago theory is practically a synonym for **autopoiesis**.

CAPRA also states: "Mind is not a thing but a **process** - the process of cognition which is identified with the process of life" (Ibid., p. 175)

He resumes the basic ideas of the theory as follows: "In the Santiago theory, cognition is an integral part of the way a living **organism** interacts with its **environment**. It does not react to environmental **stimuli** through a lineal chain of **causes and effects**, but **responds** with structural **changes** in its **nonlinear** organizationally closed **autopoietic network**.

This type of **response** enables the **organism** to continue its **autopoietic organization** and thus to continue living in its environment. In other words, the organism's cognitive **interac-**

tion with its environment is intelligent interaction... manifest in the richness and **flexibility** of the **organism's structural coupling**" (1991, p.269)

The basic importance for **cognition** of the **interactions** of the living **organism** with its **environment** was already clearly sensed by J.von UEXKULL in his theoretic biology and **ethology** research (1928, 1934) and, in a different way by A. KORZYBSKI in his work about the relations between our **perceptions** and the way we construct our **abstractions**, as well as about our very semantically based **reactions** to our perceptions (1950)

→ Semantics; Structural differential

2916

SATISFACTION PRINCIPLE^{1) - 2)}

"When affected by undesirable **disturbance** the **organism** changes **control** so that the (vital) performance indicators (**variables**) stay within the **satisfaction range** as long as the **disturbances** stay within **uncertainty sets**. Furthermore, any **control** which accomplishes such a **state** is equally acceptable" (M. MESAROVIC et al., 1973, p.68).

This principle was enunciated by M. MESAROVIC et al in relation to **modeling** of biological **functions**.

It offers a noteworthy similarity with LE CHATELIER Principle, only that its working is more complex, because it implies **regulations of regulations**, by its dependence from a defined **satisfaction range**.

2917

SATISFACTION RANGE^{1) - 2) - 4)}

The range within which some **variables** (in biological systems) "... can fluctuate without seriously affecting the normal functioning of the **organism**" (M. MESAROVIC et al., 1973, p.68).

This notion, introduced by M. MESAROVIC et al., implies a principle of economy as, within the defined range, the system's **regulators** are not uselessly overburdened.

It would be interesting to consider the possible existence of satisfaction ranges in animal and human **social systems**.

2918

SATURATION¹⁾

State of a system that has already absorbed the maximum quantity of **inputs** needed for its correct functioning.

Sub-saturation induces the search of complementary **resources** by the system.

Over-saturation provokes the clogging of the **structures** and the braking, if not the blocking, of the **functions**. It can be observed mainly at the material **level** as in obesity or bureaucratic **multiplication** or, at the **information level** where an excess of **data inputs** overflows the capacity to assimilate and synthesize.

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

However energy over-saturation may trigger **structuring dissipative processes**.

2919

SATURATION (Structural)

→ **Structural Saturation**

2920

SCALAR²⁾

A physical quantity expressed by a number on a precisely defined **scale**.

2921

SCALE²⁾

A system of regularly spaced marks used as a **reference** standard for comparative **measurement** purpose.

Scales are generally arithmetic or logarithmic, providing however quite different **representations of dimensions and rhythms in phenomena**.

2922

SCALE- FREE NETWORKS²⁾

A type of network that has many **nodes** (or **hubs**) with few **links** and some few nodes with many links. A.L. BARABASI (2002) has shown that many **communication** systems (whatever the nature of the communication) are scale-free networks. Among them he signals the Internet web, the food webs in **ecosystems** ("who eats whom"), the so-called "invisible college" among scientists (among them systemists and cyberneticians, we should add) and in biology, the complex grid of biochemical products that sustains any living being.

In this very Encyclopedia, a mapping of the cross-references would probably show out as a scale free network.

As a result of their peculiar topology, scale free networks are very resistant to not excessively extended random failures. On the other hand, any propagation of an effect can be modeled by a scale free network. An example is the AIDS pandemics.

Even one single bearer of the HIV can act as a hub in the network, i.e. as an efficient propagation agent in some specific geographic and social conditions. On the contrary, it seems that "cleaning" hubs in internet, could be a useful strategy against viruses.

→ **Hexagonal space filling: Hub; Small world effect; Social system**

2923

SCALE GRADIENT²⁾

"The continuum of **structures** which are seen by an **observer** who continuously **changes** the **size** of his **observation window**" (T.F.H. ALLEN & T.B. STARR, 1982, p.277).

ALLEN and STARR comment: "A disjunction in a scale gradient occurs when very little if any of the substance in the system under investigation is held in **configurations** with **endogenous cycling times** which are simply in tune with the **observation window** in question" (Ibid).

2924

SCALE INVARIANCE²⁾

The permanence of some structural or functional property at different **levels** (say **micro-, macro-, mega-**).

Fractals are scale invariant. WEIERSTRASS' **renormalization** equation is a formalization of scale invariance. See: "**Self-similarity in WEIERSTRASS function**".

D. RUELLE observes that scale invariance in space is related to scale invariance in time (1991, p. 98).

→ "**FEIGENBAUM's number**".

2925

SCALE (Large and small): their relationship^{1) - 2)}

Large and small scale **phenomena** and systems are interrelated **structurally** (in **space**) and **functionally** (in **time**).

Their **structural relations** are obvious, as J. MILLER, for instance, has shown in "Living Systems" (1978): Societies are made from individuals, individuals from **cells** and **cells** from molecules and atoms.

Functionally, **short term phenomena** remain within the frame of **long term** ones: the **waves** within the **tide** and the **tides** within the geological **variations** of seas **level**. (an example that can be also used as a metaphor).

Any **linear extrapolation** from small scale **variations** into **long term** is probably illusory and this explains, for example, many costly **planning errors**.

In most cases, a comprehensive study of embedded **short, medium and long term** movements (and, if more or less regular, of **cycles**) may give important leads for a more realist understanding of ongoing **transformations**.

→ **Cycle**

2926

SCALE (Mesoscopic)²⁾⁴⁾⁵⁾

(From the greek "mesos"= middle)

R. IRION writes: "Objects ranging from a few nanometers to a tenth of a micrometer show special properties that do not occur on **microscopic** or **macroscopic** scales. At this **size threshold**, adding more particles often makes the material not just bigger, but entirely different. Groups of hundreds to thousands of particles -dumb, inanimate **matter**- suddenly be-

gin to organize themselves into **patterns** that make them seem capable of responding to their surroundings"(2001, p. 33)

The mesoscopic scale is shaped through a set of stabilized and repetitive **interactions** that become functional. Another angle on this **phenomenon** is expressed by CSANYI's concept of the "**zero system**" emerging out of an **autogenetic** assembly of precursor **components**

The mesoscopically **self-organizing system** can itself be recognized at different scales. It is obviously active in all cases of self-organizing **human systems**, in **history** and in the present time. (J. WARFIELD, to be published)

M. ROUKES makes the following comment: "At the mesoscale, **matter's** properties result of a combination of classical physical laws and of **quantum mechanics**"(2001)

Many quanta effects are self-compensating, or somehow constrained at large scale. But the trend towards miniaturization and nanotechnology is bringing important techniques (as for example in **computer hardware**) closer and closer to a **critical limit** where quanta effects cannot anymore be ignored. This is now a very basic issue in applied **technology** as related to scale.

2927

SCALE (Ratio)

→ **Logarithmic growth (Semi), Optimum (Dynamic), Ratio scale**

2928

SCALE UNIT²⁾

"The minimum interval in terms of which the scale of the **magnitude** can usefully or definably be graduated".

D. Mc KAY, author of the definition, adds: "For a **magnitude** imprecisely known it is defined... to be equal to the probable **range** of error... But it should be remembered that in theoretical **representations** the **size** of the scale-unit is generally limited by our inability to *define* a smaller unit in terms of the *coincidence-relations* out of which physical **representations** are constructed" (1969, p.168).

Different scale units correspond to different **levels of observation**, and the lesser ones are in a sense embedded into the higher ones. The **understanding** of the various scale units to be used is of utmost importance in the study of complex **cyclical** or **cyclomorphic phenomena**.

2929

SCALE-FREE²⁾

Characteristic of any system whose **structures** and **behavior** are submitted to **power laws** encompassing various orders of **magnitude**.

This property is related to **self-organized criticality**.

In subsystems, the **parts** or **subsystems** have an **organization** similar to the **whole**, i.e. they have a **fractal structure**.

→ **Renormalization; Self similarity**

2930

SCALING²⁾

A **situation** or **process** in which the smaller-scale **structure** or **function** is similar to the larger one.

Sir d'ARCY W. THOMPSON established the notion in his book "On growth and form" (1916).

Scaling furnishes the base for **self-similarity** at different **levels** and is closely related to **fractals**. It has been given a precise mathematical meaning through the **WEIERSTRASS function** and the **renormalization group transformation**.

B. MANDELBROT observes: "Scaling is... an ancient idea, thoroughly familiar to LEIBNIZ; and the scientific application of scaling is the work of many hands" (1982, p.108). He cites Julian HUXLEY's **allometry**; the work of Lewis FRY RICHARDSON in **turbulence** theory and the urbanists' central place theory.

According to J. GLEICK "...**fractal** scaling (is) not just common but universal in **morphogenesis**" (1987, p.110).

It provides a **mode** of **space** occupation allowing for optimum fine structuration at any **level**.

2931

SCALING (LAW of QUARTER POWER)²⁾

This law is stated as follows by R. LEWIN (1999, p.35):

"... many biological **variables** tend to increase or decrease in relation to body mass raised to the power of one quarter or three quarters"

This law "holds true for the smallest micro-organism to the largest animal, the blue whale... a staggering 21 orders of **magnitude**... (and it) remains intact even in the subcellular domain, down to the mitochondria which provide the **cell's energy** and, beyond that to the molecular complexes within the mitochondria... to 27 orders of magnitude" (Ibid)

According to G. WEST, as quoted by LEWIN: "You find scaling everywhere in the **Universe**... as it reflects something of the general properties of the system" (Ibid, p.37)

Scaling is closely related to the nature of **networks** at the various **levels** of **organization** and **energy flows**.

→ **Space syntax**

2932

SCALING PRINCIPLE^{1) - 2)}

B. MANDELBROT distinguishes two different aspects of the scaling principle:

"A. Scaling principle of natural geometry: To assume that small and large features are identical except for scale is often a useful approximation in science.

"B. Scaling principle of mathematical geometry: To limit oneself to **sets** wherein small and large features are identical except for **scale** is often a convenient procedure in geometry.

He adds: "Part of my work consists in viewing B as having provided a collection of answers without questions and in setting them to work on the questions without answers summarized under A.

"The only fairly wide justification for A is that any sum of many **effects** satisfying a "central limit theorem" is scaling. This statement is, of course, too loose to be provable, yet a prudent addition of natural assumptions makes it into provable theorems or plausible conjectures" (1982, p.96).

2933

SCANNING²⁾

Any technique by which recorded **information** can be reviewed for **selection**, use or **transformation**.

Such techniques are basically electronic or optic and are very useful to investigate the internal **organization** of **complex systems**.

A **metaphorical** (but not very proper) extension of the term covers the quick visual and superficial examen of printed material.

2934

SCENARIO 1⁴⁾

A technique in futurology (or **prospective**) consisting in describing a possible future based on existing **data** and selected assumptions.

M. MARUYAMA prescribes the following steps, in accordance with his concepts relative to **interconnected positive and negative causal loops** (see 2nd cybernetics):

"1. Make not one, but several scenarios.

"2. The **purpose** of the scenarios is to consider various possibilities, *not* to make a **prediction**. Therefore they are useful to the extent that they include novel, unusual **elements**. The scenarios made in the past tended to **extrapolate** present **trends** quantitatively. But we need scenarios which include novel qualitative **changes**.

"3. For each causal **diagram**, first put down a novel **element**, such as fertile arid land or outer space industry. Then put down **variables** which are affected by this **element**, as well as **variables** which will affect this **element**. Draw causal arrows with plus or minus signs, strength indicators and **delay** indicators.

"4. Draw causal arrows to and from these **variables** from and to still more **variables**. Repeat the **process**.

"5. Eventually, the diagram becomes too crowded. Eliminate the **variables** which have weak direct or indirect **relations** to the first **element**, as well as the **variables** which have weak effects on the type of business category or the firm for which you are making the future scenario. A workable number of finally selected **variables** is between 10 and 15.

"6. Make a list of all the **loops** found in the diagram.

"7. Eliminate **loops** which have weak **loop** strength or too long a total **time delay**, say 50 years or more.

"8. Now you have a small number of **loops** to consider. Write down in sentences the **dynamics** of these **loops**.

"9. For each scenario, determine whether your firm is a loser or a winner in comparison with your competitors.

"10. Work out a **strategy** to make your firm a winner, and examine its feasibility and obstacles.

"In this type of exercise, you discover that **causal loops** behave in a way very different from what you expect by looking at each causal arrow separately" (1994, p.87).

This way to construct scenarios is satisfactory in systemic and cybernetic terms. It does however still depend on the personal acumen and judgment (or, unfortunately, prejudices and ignorance) of the researcher. The case is quite similar to the construction of the basic **model** in FORRESTER's **systems dynamics**.

2935

SCENARIO 2^{1) - 2)}

A structured behavioral **model** that orients **behavior** in specific circumstances.

The concept has been developed by R.C SCHANK who hypothesizes that we possess "**memory organization packets**", in fact connected stories, gathered from former experiences, which are at our disposal everytime we find ourselves in a **situation** that acts as a **trigger**.

He gives as an example "restaurant **behavior**", as different from "fast-food **behavior**". The **model** has been experimentally confirmed by **computer modelizations**, wherein the **program** stores experiences that can be reused in similar cases (1995, p.151-2).

2936

SCHEMA^{2) - 3)}

1. "A mental **structure** that **codes** and stores external **inputs**, driving the search of the **organisms** for new inputs" (E. PESSA, 1992, p.433).

E. PESSA quotes NEISSER who redefined the concept (1976). He explains that the **structure** is influenced by the **inputs** "when they cannot be coded by using the existing **categories** and a schema modification is required. On the other

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

hand, we have a trend toward self-consistency, because the **organism** is searching only for the **stimuli** that are required by the schema itself" (Ibid).

This is the **autopoietic** aspect of the schema: it tends to **organizational closure**.

This schema concept also seems useful in **organizations**, which apparently react in the same fashion.

Schema construction is more or less equivalent to **back propagation algorithm** shaping.

2. "A **symbolic structure** that can be filled by a specific type of **information**" (E. BUCHBERGER, 1987, p.51).

This is a more formal meaning, in no way contradictory to the former one.

From the viewpoint of **culture**, schemas are social constructions obtained through **consensus**, and transmitted by **imitation** or **education** (H. PLOTKIN, 2000, p.60)

Schemas do undergo a frequent process of **transformation** through **reevaluation** of their soundness, by debate.

2937

SCHEMATA²⁾

"Efficient adaptive plans" (J. HOLLAND, 1992, p. 19).

HOLLAND writes: "Schemata provide a basis for associative combinations of **attributes** with potential for improving current **performance**" (p.68).

He develops the corresponding **methodology** to evolve schemata, that can be used to establish or to describe the best coordination **rules** in adaptive **automata**. (p.66-74)

2938

SCHISMOGENESIS^{1) - 2)}

"Progressive **differentiation**" (G. BATESON, 1973, p.42).

This concept is more or less equivalent to MARUYAMA's **deviation - amplification processes model**. It is also related to **polymorphism** in **populations**, as considered as a factor of **evolution**.

BATESON distinguishes:

- a. symmetrical schismogenesis, where the mutually promoting **actions** of A and B are essentially similar, e.g. in case of **competitions**, rivalry and the like;

- b. complementary schismogenesis, where the mutually promoting actions are essentially dissimilar but mutually appropriate. e.g. in cases of **dominance-submission**, **succouring-dependence**, **exhibitionism-spectatorship** and the like" (p.82).

2939

SCHOLASTICISM¹⁾²⁾³⁾

R. GLANVILLE writes (1999): "One aspect of Scholasticism of great significance was the notion of the **organization of knowledge**.

The scholastic philosophers believed that the way pieces of knowledge fitted together was itself a sort of knowledge. They organized knowledge so that knowing the place of any piece of knowledge in the grand scheme of knowledge (the totality), its **connections** to the **whole**, and, in principle all knowledge- the totality- could be deduced. Every **part** implied (was in concordance with) every other part (each was manifest in the others)"

Glanville quotes PANOFSKY's work on "Gothic architecture and scholasticism"(1957), "arrangement according to a system of homologous **parts** and parts of parts". He adds: "The latin words were *summa*, *concordantia* and *manifestatio*. It is no wonder that the scholastics invented the Encyclopaedia in a form in which we know recognize it"(Ibid)

Today there is obviously a need to compensate- not to eliminate- the massive disjunction between so many specialized disciplines. Systemic and cybernetic **concepts** and **models** should be considered as **semantic** and **linguistic connectors**, that can be used to construct a renovated connected and coherent general **language**, reconstructed in the spirit of scholasticism.

→ **Transdisciplinarity**

2940

SCHOOL¹⁾⁴⁾⁵⁾

A large **group** of fishes or other aquatic animals, swimming in a coordinated way (Synonym: shoal)

By swimming together in large numbers, the members of the school obtain a reciprocal protection because all those who are inside the shoal cannot be easily reached by any predator.

Only the peripheral individuals have incomplete protection. However all members take turns to occupy the exposed **positions**. A somewhat similar **behavior** can be observed in migrating birds (ducks, swallows, for instance)

The school **phenomenon** is obviously a very basic root of **sociality**. It shows the importance of environmental pressure that generates **cohesion**, **coalitions**, **coordination** (and generally what could be called "co-behavior") in groups of originally isolated individuals.

Curiously enough, the school behavior became the **response** of oceanic convoys to submarine attacks during World War II. This behavior was one of the first results of **operation research**

2941

SCIENTIFIC METHOD: A constructivist reappraisal³⁾

The classical concept of scientific method left mental, psychological and **consensual** aspects out of the picture, thus creating the illusion of **objectivity**.

The **constructivist** view explains various formerly puzzling aspects:

- How could we get scientific controversies (some of them quite heated) and "revolutions" (T. KUHN).
- Why and how should scientific theories be falsified (K. POPPER).
- Why did we need a **theory of logical types** (B. RUSSELL - A.N. WHITEHEAD) and why could no scientific - or, for that, logical - explanation be self-validating (K. GÖDEL).

H. MATURANA puts the **constructivist** viewpoint in this way: "As scientists we make scientific pronouncements. These pronouncements become validated through experiments that we make, according to scientific method. This method can be retraced in the following way:

a) *Observation* of a **phenomenon**, *seen* as a problem to be solved;

b) development of a *hypothesis* in the guise of a **deterministic** system able to produce a **phenomenon isomorphic** to the observed **phenomenon**;

c) *generation* of a **situation** or **process** which, in coincidence with the proposed hypothesis, could be *observed* as the **predicted phenomenon**;

d) *observation* of the **predicted phenomenon**" (1982, quoted by P. HEJL, 1985, p.111) (this compiler's italics).

Every italicized term bears a mental or psychological load and, consequently, the results cannot be taken for an absolute **representation** of reality.

Moreover, the construction of so-called scientific **truth** is altogether a matter of **consensus** among scientists, after due debate. And still, such **consensus** is always provisional, until someone challenges it with new **observations** or hypotheses. In this case, the whole **process** must be rehearsed, with unforeseeable results.

2942

SCIENTIFIC REALISM³⁾

In his review of Ch. LANDESMAN's "Introduction to Epistemology", J.van GIGCH writes:

"Scientific realism is a claim about the aims of scientific inquiry. It is a form of **realism** and rejects the various forms of **idealism** and **constructivism** which say that the world we are trying to gain **knowledge** of, does not have an independent and objective existence. It also rejects the **skepticism** which claims that this aim is unrealizable. According to LANDESMAN, "scientific **activity** is a self-correcting activity that is progressive: it gradually provides better and better accounts of the way the world is, and eliminates theories that are epistemically defective"(1999, p. 90)

In fact, these views are very similar to POPPER's.

LANDESMAN adds: "If the success of applied science is no accident, that it is plausible to suppose that our theories capture at least some aspects of reality to some extent" (Ibid)

Of course, even the philosopher most skeptical about reality will not skip his dinner because he cannot be sure it is "real".

→ **Ontological skepticism**

2943

SCLEROSIS^{1) - 4)}

An excessive proliferation of **elements** in a system, that progressively impedes its correct working.

Translated outside biology, sclerosis would seem merely a **metaphor**. However the progressive proliferation of supernumerous **elements** can also be observed in **human social systems**.

F. ROBB writes: "As the institution/**distinction** systems elaborate and expand, so their **efficiency** at doing this should decrease. The **models** which provide meaning should no longer be sufficient to explain **objects**, **events**, and the **processes** encountered in the world. As the institution extends its **boundaries**, there should be a proliferation of **rules** and an increase in the **complexity** of the **classifications** they make. This should increase until the **distinctions** are too complex to convey meaning. The **efficiency** of the institution in making use of the available **energy** should then decline" (1990, p.395).

Sclerosis is probably comparable to ASHBY's too **richly joined** systems, wherein excessive **constraints** reduce **adaptiveness** up to the point of eventually suppress it outright. This leads unavoidably to the demise of the system.

The basic reason for such a **process** is possibly the unending accumulation and **storage** of acquired **adaptations** (many of which will never be used again) and the resulting reduction of the globally limited potential for further **adaptations** in any **autopoietic** system. This may be the conceptual nexus between **ageing** and sclerosis.

It would be of systemic interest to closely investigate the sclerosis **process** in general terms and try to formalize it.

2944

SCRIPT¹⁾

A **semantic description** of a **behavioral pattern**.

According to M. BODEN: "Scripts and **frames** can be thought of as special cases of **semantic nets**. They represent the conceptual skeleton of a familiar idea – such as how one should behave in a restaurant, or what it is to be a room, or a molecule. In other words they are schematic outlines of a tiny part of conceptual **space**. Like **semantic nets** in general, they

can be modelled by **connectionist** systems... Scripts concern socially recognized ways of behaving (involving the **roles** of customer and waiter, for instance)" (1990, p.97).

Current A.I. scripts are thus far more limited than mental scripts.

2945

SEARCH CONFERENCES¹⁾⁴⁾

Search conferences were proposed by F.E. EMERY (1993). M. JACKSON describes them as follows: "(They) emerged from socio-technical systems theory and aim to involve people in the creation of their own future. They promote the development of democratically self-managed **groups** and insist that all those directly involved in a **situation** should participate.

In the case of groups exceeding the recommended fifteen to thirty people for a single search conference, parallel multi-search conferences are organized. They work within organizational and **community contexts** to "rationalize **conflict**", provide a thorough **understanding** of environmental **issues** and **constraints**, and to promote learning" (2000, p. 310)

Fuschl and Asilomar Conversations can be seen in this light, but it should be made clear that they do not include formal presentations and discussion of papers and that the agenda itself is constructed through open and free debate among the participants.

→ **Assumptions; Brainstorming; Codes (Linguistic and semantic); Communication (Human); Consensus; Conversation; Design inquiry; Frame of reference; Language; Observer**

2946

SEARCH (Random)²⁾

A search without pre-instated **rules**.

This is supposed to be the way mutations and natural **selection** do operate.

H. PATTEE observes however: "The first criticism is that random search cannot be expected to 'find' successful **organization** because the search space is so immense. Thus a search for just one sequence of 100 amino acids representing one functional enzyme would require of the order of 20^{100} trials which is not within any reasonable probability within the age or **size** of the universe" (1972, p.38)

H. SIMON proposed his **Hora and Tempus metaphor** about **progress** towards evolutive **complexity** by **hierarchization** as a possible reply to this riddle (1965).

H. PATTEE pursues: "The second criticism is that functional optima or **fitness** peaks in the adaptive landscape appear to be local, separate optima, so that no evolutionary pathway can be imagined that does not pass through nonfunctional or lethal valleys. Random search and **selection** can provide a mechanism for **adapta-**

tion with respect to one of these optima, but for any **fitness** landscape with a realistic number of dimensions, the trapping problem becomes unsolvable" (Ibid).

His conclusion is that we need a mechanism of **self-simplification** to escape from this impossibility. Notably, he considers, like SIMON, that **self-simplification** must be based on **hierarchy**.

2947

SEARCH SPACE²⁾

"The **set** of the **states** through which a problem – solver could conceivably pass in seeking the solution to a **problem**" (M. BODEN, 1990, p.77).

M. BODEN specifies: "In other words, it is the **set** of conceptual locations that could conceivably be visited. "Conceivably" here means "according to the **rules**". Contrary to popular belief, a creative **genre** may be based on precisely specifiable **rules**" (Ibid). M. BODEN gives the example of classical musical composition, based on the **rules** of harmony and observes that dodecaphonic music is also based on a **set** of specific **rules**.

2948

SEGMENTATION^{2) - 4)}

Condition of a system such that each **component** is a structural and functional replicate of every other.

Be it in genetics, in **pattern recognition**, or in **sociosystems**, segmentation takes place according to interacting **rules**.

The concept has been used by L.A. WHITE (1959, p.145-149), who observes that: "The **process** of segmentation is observable everywhere and on all **levels of organization**, physical, biological, and social" and adds: "We now come face to face with a very interesting and apparently fundamental principle: any system, whether it be a segment itself or an **organization** of segments, has a maximum **limit of size**".

WHITE gives a number of physical, chemical and biological examples and concludes: "Thus we observe two aspects of material systems of this sort:

"1. Units tend to combine and form **integrated systems**.

"2. The integrative **process** cannot form larger and larger systems indefinitely; there is a maximum **size** and **limit** for each kind of system" (Ibid, p.146).

WHITE applies this concept to human societies and finds that it is the basic mechanism of **emergence** of more complex **socio-cultural systems**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

C. FRANÇOIS showed that the **level of complexity** thus attained is related to the the degree of mental and technological development of each human group and that there is an **evolution** toward the **emergence** of ever less numerous, but more complex ones (1993, p.74).

2949

SEGREGATION (Interactive)^{1) - 4)}

The spatial separation of different **groups** through some **code** of reciprocally perceived deterrent or repulsive **signals**.

Interactive segregation has been observed among **populations** of different species of fishes within a common biotope. It results of the production and reciprocal **perception** of biochemical substances by these species (P. SAGLIO, 1992, p.1292). It should be of interest to find out if this mechanism for optimal use of common **resources** through diminishing interferences and infighting does also exist under other forms among other species or **groups**, including human ones.

2950

SEGREGATION (Progressive)^{1) - 4)}

The **process** through which "**components** of a system become increasingly more independent and isolated, leading to the eventual dissolution of the system" (B. BANATHY, 1973, p.88).

According to HALL & FAGEN the concepts of **totality** and **additivity** must be clearly distinguished. By **additivity**, they seem to understand the existence of clearly identifiable parts in the system.

They describe (in a somewhat ambiguous way) two possible modes of progressive segregation in a system.

The first one is related to the **breakdown** of the system: certain **parts** stop functioning and slowly, the functional **interrelations** disappear, up to the point of complete **disaggregation** of the system.

The second one corresponds to **growth** and is somehow antithetical to the first one: "The system changes in the direction of increasing division into **subsystems** and **sub-subsystems** or **differentiation of functions**" (1956, p.22) The authors use as an example the embryo's development or the **differentiation** of a **communication net**.

The difference between both **processes** is so significant that it does not seem quite adequate to use the same expression in both cases. "Progressive segregation" could be restricted to the decomposition **process**. Conversely, structural and functional subdivision, which corresponds to a growing degree of **heterogeneity**, could be called for example, "Progressive **differentiation**".

However, starting from the initial **autogenesis**, progressive **differentiation** and progressive segregation seem to constitute a natural sequence in **complex systems**, in accordance with the **2nd principle of thermodynamics**.

2951

SELECTION¹⁾

Selection is a limiting, negative **agent**, that results in the elimination of some types (biological, economic or social). As observed by W.R. ASHBY, it is equivalent to a "**mapping** that reduces the original **domain** to a **subset**" (1964, p.96). It could however not work without the previous **action** of a creative variegating **agent**, as was already observed in 1921 by A. BOGDANOV in his "Essays in Tektology", where he distinguishes between a conservative and a progressive selection (1980, p.74-85).

According to N.C. MARNEY and N.M. SMITH, "in **dynamic systems**... the whole business of natural selection... amounts to the automatic generation of **subsystems** that are specially resistant to the **perturbations** characteristic of some particular **subenvironment**" (1964, p.119):

Such a **mechanism** must be some kind of branching **self-organization process**, whose precise nature and workings have remained quite elusive until the recent development of **far-from-equilibrium thermodynamics**. A promising possibility to model branching **processes** has been signaled by St. KAUFFMAN in his book "The Origins of **Order: Self-Organization and Selection in Evolution**" (1993).

Order may emerge from **interactions** between **components**, as shown for instance by M. MARUYAMA's **deviation-amplifying mutual causal processes**, based on the effects of **rules** on some **initial state**, or in J. CONWAY's **models** known as "**Game of Life**", a particular case of **self-organizing automata**. According to KAUFFMAN, such **processes** may lead to the "**edge of chaos**", where the possibilities for innovation are maximal. This in turn opens the way to selection.

KAUFFMAN also hypothesizes that the general increase in **complexity** of systems (specially biological ones) progressively orients and restricts the role of selection. This could be a key to explain F. MEYER's **evolutive acceleration** (1954).

Complementary to this view is R. MARGALEF's: "Selection is a **filter**, but one that in turn evolves. There is a selection of **mechanisms** and motives for selection" (1980, p.93).

2952

SELECTION (Artificial)²⁾

→ **Evolution (Artificial), Fitness Function, Parallel distributed processing, Robot (Khepera), Synaptic weights**

2953

SELECTION (Frequency dependent)^{1) - 2)}

In polymorphic **populations**, some slightly different morphs may offer better **survival**. However, the favoured **forms** stay rare "because the commoner it gets, the more the selective pressure builds against it" (C. TUDGE, 1992, p.25).

In these cases, the **survival** value is inversely proportional to **frequency**. Only some **change** in the ecological **context** could alter this kind of **situation**.

It should be interesting to look for similar situations in societies in relation to some uncommon cultural types.

2954

SELECTION IN POPULATIONS (Combinatorial)^{2) - 4)}

This concept has been proposed by W.M.S. RUSSELL (1961, p.84) and may be resumed as well as generalized in the following fashion:

1. In any population widely scattered in a very diversified **environment**, new characters may appear at **random** in many different places;
2. If the **environment**, while diversified is not fragmented, no splitting of isolated populations will tend to happen and no new species will appear;
3. Thus the global pool of diversified characters will tend to increase;
4. Faced with even wide **variations** of the **environment**, the population will be able to adapt. Some characters will become widely represented and others numerically quite reduced. However, probably none will disappear totally.
5. **Variety** being globally enhanced, the population as a whole will have a greater **survival** potential.

The concept is related to, and explains **polymorphism**.

These ideas can be applied in quite a number of very different **situations**:

- In unstable climatic **environments**, as for example in West African Sahel, considerable genetic **variety** in cereals guarantee at least a minimum harvest, be the climate too dry or too rainy, and whatever kinds of pests are present and moreover, without any need for artificial fertilizer, pesticides or irrigation schemes.
- In human populations, according to RUSSELL. "Cultural rigidity... is accompanied by socio-economic decline" (ibid, p.58). This has probably been one cause of the demise of Soviet Union, and also of numerous archaic human groups and, in another setting, of many businesses stifled by authoritarian rule.

2955

SELECTION K ²⁾⁽⁴⁾⁽⁵⁾

A **co-evolution process** in which, in an **environment** whose all disponible **niches** are completely occupied by simple **forms**, the **selection** pressure leads to the appearance of more complex **forms**.

This is originally an ecological principle, which could be related to other systemic features in embracing complex systems.

One is LOTKA's **World Engine**, which gains global **efficiency** when more and more specialized (which generally means more complex) **transformers** become able to use some formerly unused supply of **energy**.

Selection K also could be related to the subdivision of **energy vortexes** leading to the qualitative differentiation of **channels** in **energy flows** (Ch. LAVILLE)

The **process** could moreover be related to the general **model** of **fractalization**.

Selection K could possibly be translated as a principle of social and cultural **evolution**, specially under the condition of historically growing use of **energy** by mankind.

2956

SELECTION (Multi-level) ¹⁾⁽²⁾

The existence of the **mechanism** of selection at different levels in life's **evolution** and **organization**

The idea that natural selection operates not only on individuals but also on **groups** has been first suggested by DARWIN. Groups may adapt to much more extended and complex **environments** than individuals. And, as some groups are more apt to discover good collective **adaptations** than others, being a member of a successful group brings a supplementary advantage to an individual.

A powerful objection to the value of group selection was that it would encourage cheats to benefit from the group without contributing to its progress. It seems in effect that most groups have their cheats (Be them "selfish genes" or parasitic bureaucrats). However, in case of coping with a really harsh **environment**, the group becomes much more intolerant to internal **parasitism** by cheats. Moreover, the group which tolerates too much cheating easily loses its selective advantage and may be eliminated by those who demand more solidarity of their members.

The collective and individual gains from group collaborative **behavior** or solidarity may even explain why **groups** tend to appear at different **levels** of **organization** and could be considered as the main root of **sociality**.

Evolution could finally offer an alternance of level selection among individuals and emergence of more complex forms of **organization**, later on again submitted to selection at a higher **hierarchic level** (J. MAYNARD SMITH & E. SZATHMARY, 1999)

→ **Cooperation as an evolutive process**

2957

SELECTION (Natural) ¹⁾

This widely debated concept is thus commented by P. CORNING: "... in fact, natural selection is an "umbrella" **category** that refers to whatever functionally-significant **factors**, (as distinct from, say, **stochastic** or **teleological** influences) are responsible in a given **context** for causing the differential **survival** of genes, genic "interaction systems" (in SEWALL WRIGHT terms), genomes, **groups**, **populations** and species" (1998b, p.3).

2958

SELECTION PRINCIPLE (LOOP) ^{1) - 2)}

A system favoured by **reward loops** obtained from other systems has a better **survival rate** than others who do not obtain such benefits.

H.T. ODUM who – in an implicate way – introduces this principle, observes however: "Either too much or too little **growth** by one **component** puts the loop out of harmonious **flow**" (1971, p.150).

And: "Species whose work efforts are not reinforced are shortly eliminated, for they run out of either raw materials or **energy**. They must be connected to **input** and **output flows** to survive" (Ibid).

The principle applies to many different kind of systems as for example: a cancerous growth, an invading weed, a successful business, a learning brain, etc...

2959

SELECTION (Replicative) ^{1) - 2)}

According to V. CSANYI, only **processes** that do not destroy the system are incorporated (which is self-evident) and, combined with other ones, enter in **self-reproductive cycles**.

CSANYI adds: "Any **organization** that cannot maintain its own **structure** is only temporary and irrelevant to **evolution**". Replicative selection works its way from the cellular **level** up to the whole **biosphere** (1989, p.78).

2960

SELECTION (The conditions of natural) ¹⁾⁽²⁾⁽⁴⁾

The following three conditions seem to be indispensable for natural selection:

- **reproduction** and multiplication of individuals of a certain type
- non-destructive (non lethal) **variations** in some of these individuals

- heredity or reproduction of these **variations**

A supplementary condition seems to be **variation** in the **environment**, which may have a positive or negative value for the **survival** of specific **variations** within the group.

Variations increases **variety** (in Ashby's sense) and becomes a favorable factor in a variable **environment**.

Selection reflects internal and/or external **constraints**.

Natural selection in species applies to species as **wholes**, but acts through the relative **fitness** of individuals, which in turn reflects **fitness** of their genes.

These concepts are very probably valid in all kinds of societies. In particular, the new emerging field of **Artificial Life** uses the three **processes** with the same results as to the "survival" and **growth** of the **colonies** of **elements** in a well defined **environment**

2961

SELECTIVE REPRODUCTION (in Artificial Evolution) ¹⁾⁽²⁾⁽⁵⁾

"Selective reproduction consists of a **linear** scaling of the **fitness** values followed by a probabilistic allocation of a number of offsprings proportional to the fitness value of each individual" (D. FLOREANO) et al., 2002-2003, p. 15)

This means that any individual (**robot**) is "born" with its proper set of characteristics. While adapting only its own **behavior**, any new characteristic can be transmitted to "individuals" of the next generation but only if compatible with the characteristics of other individuals.

It should be observed however that some aspects of this **process** are not yet really well understood and that debates and experiments are going on.

One of the participants states however clearly that "**learning**" ("apprentissage") must be distinguished from "evolution" (see also J.A. MEYER, 1998, p. 46-50)

The bridge crossing from LAMARCK to DARWIN still remains insecure!

→ **Animat; Artificial life; Neural network; Selection**

2962

SELECTIVITY ¹⁾

The ability of a system to select a satisfactory **response** to any stimulus.

Systems must constantly be able to select a convenient **response**, either to a **variation** in their **environment**, or some internal **perturbation** evoked by such a **variation** (directly or not).

The first condition to do that is to dispose of a suitable **choice** of possible **responses** (**Requisite variety law**)

If this condition is fulfilled, the **choice** still must take place. This is where selectivity enters.

According to H. SIMON, there are two basic kinds of selective **processes**:

"1. Various **paths** are tried out, the consequences of following them are noted, and this **information** is used to guide further search".

Of this first **process**, SIMON gives the following example: "...in organic **evolution** various complexes come into being, at least evanescently, and those that are stable provide new building blocks for further construction. It is this **information** about stable **configurations**, and not free **energy** or **neguentropy** from the sun (Note: which is, in any case, the prime mover) that guides the process of evolution and provides the selectivity that is essential to account for its rapidity"

"2. The second source of selectivity in **problem solving** is previous experience. We see this particularly clearly when the problem to be solved is similar to one that has been solved before. Then, by simply trying again the **paths** that led to earlier solution, or their analogues, **trial and error** search is greatly reduced or altogether eliminated".

"The closest analogue (in organic **evolution**) is reproduction. Once we reach the **level of self-reproducing systems**, a **complex system**, when it has once been achieved, can be multiplied indefinitely" (1965, p. 68).

2963

SELECTOR²⁾

Any device equipped with a preference **function**.

K. BOULDING, who tried to give a clearer content to the term, recognized himself that such a definition is nearly tautological (1972, p.68).

Moreover, the word preference is tainted with anthropocentrism.

Even so, the selector must necessarily contain some discriminating **description** of what it is supposed to reject or to select among the **inputs** received from the **detector**, and the capacity to transmit this **information** to the **effector**.

2964

SELF-¹⁾

A prefix used in many composed words, that indicates some **feedback** of the system on itself, or some reciprocal **feedback** between **elements** that tend to organize as a **whole**.

2965

SELF (The): A proposed systemic interpretation¹⁾⁵⁾

R. NUMMELA CAINE and M. CAINE resume as follows in systemic terms the self-concept as elaborated by a number of theorists: "The self

is a uniquely organized system made up of **beliefs**, biases, **memories**, predispositions, expectations, **knowledge**, fears, **reactions**, **behaviors**, talents and **meanings**" (1994, p.136).

What would be needed is a way to relate more precisely among themselves all these **components**... and moreover, give them an adaptive dynamics, i.e. an **autogenesis** and an **autopoiesis** of the self.

The authors contribute an interesting, if still partial, proposal to achieve this, namely their **concept of learning as self-reorganization**.

2966

SELF-ASSEMBLING^{1) - 2)}

The characteristic **behavior** of some **dissymmetrical** molecules, which tend to cluster together into more complex, but similarly **dissymmetrical** systems.

The self-assembling capacity can probably be considered as the very root of the basic associative **processes** in nature.

In G.M. WHITESIDES words: "Self-assembly omits the human hand from the building". While in some cases: "People may design the **process** and ... may launch it,... once under way it proceeds according to its own internal plan, either toward an energetically **stable form**, or toward some system whose **form** and **function** are encoded in its **parts**". (1995, p.114)

There are many natural systems which are self-assembling, from a simple raindrop to the human beings and societies.

Self-assembly has its roots in physics and chemistry, and still more deeply in **symmetry-breaking** in energetic **processes**. This is **thermodynamic** self-assembly.

This very basic **process** led to a more complex form of self-assembly in **living systems**. In WHITESIDES words: "The construction of a cell's **complexity** is balanced **thermodynamically** by **energy-dissipating structures** within the **cell** and requires complex molecules such as ATP... (p.116).

"The kind of self-assembly embodied by life is called coded self-assembly because instructions for the **design** of the system are built into its **components**" (Ibid).

According to WHITESIDES, our machines of the future will be much more complex than our present ones and based on self-assembly.

Self-assembly is closely related to **associativity**, **autogenesis**, **growth** and **form**, **order from order principle**, **slaving principle**, **so-ciogenesis** and **stigmergy**.

2967

SELF-ASSERTIVENESS¹⁾

"Characteristic of **holons** related to their existence as quasi autonomous **wholes**" (T.F.H ALLEN & T.B. STARR, 1982, p.277).

ALLEN and STARR comment: "This tendency is related to the **holon's** capacity to maintain its integrity. This aspect of **holons** pertains to the **constraint** that the **holon** asserts over its **parts**" (Ibid).

2968

SELF-CLOSURE EVENT²⁾

The first **interaction** between hitherto unconnected **elements**, leading to the progressive, but irreversible shaping of an **autopoietic system**.

"In general, it becomes quickly irreversible, but a long **morphogenetic process** is needed in order to materialize the potential thus created. What comes with self-closure is organizational **dynamics**.

"Self closure includes the following aspects:

- an **interface** or **boundary** appears, separating clearly and in a definitive way the new system from its **environment**, defining the internal **space** it controls ("invironment").
- within this **boundary**, the system asserts immediately its **autonomy**. It becomes able to **control** its **inputs** and to react to **stimuli** from its **environment**. Eventually, it becomes able to exert some **action** on it
- the system starts at once to differentiate its more or less complex **structures** and **functions**

These organizational **dynamics** are quite well known in the case of biological systems. However, they can be recognized under different guises in **social systems**, as for example:

- the birth of an enterprise
- the birth of a natural language

2969

SELF-DESTRUCTION OF SYSTEMS²⁾⁴⁾

No system seems able to survive eternally, save possibly the cosmos as a **whole**. But even this is merely an hypothesis that cannot be proved or disproved.

Systems can be destroyed by some independent **perturbation** in their **environment**, which eventually overwhelms the **limits** of their conditions of existence.

However self-destruction is very frequent. It can happen in different ways:

- The system may be taxing its environment excessively. A tragic example has been given by J. DIAMOND describing the undoing of Easter Island people (1995), possibly the most perfect example of Malthusian self-destruction by a **population** overtaxing a closed **environment**. DIAMOND wonders if this lesson would not apply to humanity as a **whole** in relation to planet Earth.
- Some **subsystem** of the system may turn **parasitic** and consume so much **resources** as to starve the system as a **whole**, making it unable to maintain itself.

- Some internal or external **parasite** may invade the system and also divert excessive **resources** for its own benefit. Cancerous **growth** would be a biological example.

- All systems seem to have a characteristic in-built **mechanism** which limits their **survival in time**: ageing in biological systems (for ex. **apoptosis in cells**); **sclerosis in human social systems**.

2970

SELF-EFFICACY

→ Efficacy (Self-)

2971

SELF-EXCEPTING FALLACY³⁾

The attitude of a researcher who reserves a special position for him- or herself.

Such a way would imply that the **observer** tries to put her or himself as possessing an absolute **ontological** certainty (G. DEVEREUX's "**Olympian stance**"). This cannot work when the researched subject or system is endowed with some degree of **autonomy**. Only "**trivial machines**" in von FOERSTER sense can be truly specified (and constructed) by an **observer**.

2972

SELF-FULFILLING³⁾

The character of an hypothesis or **forecast** that tends to foster this same hypothesis or bring about the **forecasted event**.

The self-belief in what is hypothesized or predicted exert an influence on the results of the research done or on the future **events**. Moreover, if the belief becomes shared by numerous people, the effect may become massive. Examples are the opinion polls, which may influence public opinion to the point of producing the predicted **event**.

2973

SELF-LIMITATING PHENOMENA^{1) - 2)}

This **class** of phenomena has been researched in 1960 by S. FOX in the realm of biochemistry and in relation to the origin of life. (1960, p.59).

Self-limitation is clearly a sine qua non condition in **complex systems** if they are to reach **dynamic stability**.

It seems to be a necessary consequence, or possibly even a cause of **autopoiesis** and **organizational** (or **operational**) **closure**. It is also quite probably related to **catalysis in hypercycles**. The subject should deserve a deeper investigation.

2974

SELF-OBSERVATION¹⁾²⁾

The capability of an **object** to observe itself.

In the case of human beings, this could be the root of **consciousness**.

However R. GLANVILLE states that "Every object is a self-observer" (1978, p.303), a quite enigmatic statement in the case of non-animated **objects**.

GLANVILLE adds: "Some objects observe other **objects**. Some objects are observed by other **objects**. However an object can be non-other-observing and non-other-observed" (Ibid.)

It would be interesting to find out if self-observation makes sense in a way or other for plants, animals (specially higher vertebrates) and societies.

2975

SELF-ORGANIZATION¹⁾

Ability of a system able to construct and change its own **behavior** or internal organization

The construction of self-organization is quite different from its **maintenance**, once the organization is completed. In the first stage, **morphogenesis** is important, even if the basic **template** of the system's organization is already present and acting. In the second stage, when general organization is stabilized, it should possibly be useful to speak of self-reorganization.

→ hereafter: "**Self-organization** (Two meanings of)", for more shades of meaning.

Self-organization is a very general type of **behavior** in systems. G. DALENOORT gives some examples: "Biological **evolution**; linguistics; crystal **growth** and lasers; social **processes**" Many others could be given. Self-organization has even been discovered in some geological **processes** (Stylolites spacing - E. MERINO, 1992, p.466).

According to DALENOORT, it can be studied from many different approaches "... which usually correspond to specific **choices of representation**". He also cites some well-known formal approaches: "**Cellular automata**; Petri nets; Mc CULLOCH-PITTS **nets**; **self-reproducing automata** (von NEUMANN)", and some specific **methods**: "**Autopoiesis** (MATURANA and VARELA); **synergetics** (HAKEN); **dissipative systems** (PRIGOGINE); **catastrophe theory** (THOM); evolutionary systems (LOTKA-VOLTERRA); chemical **auto-catalytic** systems (EIGEN)" (1989, p.16)

Self-organization could be considered as the acquisition of **variety** by the system by progressive reduction of its **redundancy in response to noise from its environment**.

As observed by H. SABELLI, so-called self-organization is inevitably at some initial **state** a co-organization **process**. He stresses that, as noted by J. PIAGET, **change** is not caused by a **cause-effect relation**, but by an **interaction** between **processes**, which constantly evolve (pers. comm.).

Or, self-organization is the progressive expression of an initial potential to acquire **heterogeneity** or **complexity** by a **process of differentiation** based on **energy dissipation**, as follows:

From **Homogeneity** to **Heterogeneity**

From **Redundancy** to **Variety** and **Complexity**

From Undifferentiation to **Differentiation** and **Organization**

However, the initial **state** can evolve towards more expressed **differentiation** only under the guidance of some original **template** (as for example the genetic **code** in a biological system or the original basic **values** in a socio-cultural one).

This initial **template** is obtained from some previous system or systems and is in itself a more or less complex "recipe" for **differentiation** starting from **redundancy** (for example all merystemes in a plant are **redundant**, but each possesses that potential for **variety** in the guise of the genetic **code**).

Self-organization, moreover, is a **process** of at least partial (i.e. never totally completed) **algorithmization** of the system and is closely related to **organizational closure and autopoiesis**.

It is obviously of fundamental importance in all **learning processes**.

J.L. TABARY emits the following objection: "If an increase of **organization** is to be significant, it must produce some perceptible gain in **efficiency**. This may be obtained by an increase of the number of **non-equilibrium stationary states**, which qualify the extension and precision of **accomodation** (Note: of the system to its **environment**). It can also be obtained by a more swift and less costly use of an adapted **stationary state**, to face some specific **event**". (1989, p.286)

This comment is important because it leads to a better **understanding** that an excessive self-organization may lead to block up and **sclerosis** when an excess of **adaptations**, frequently useless, leads to a ruined **adaptability**. Good examples are the bureaucratization **processes**.

E. LASZLO gives the following basic conditions for self-organization:

"First... it necessarily involves an **open system** (or a system coupled with another system)..."

"Second,... (it) presupposes some **inputs** from the system's **environment** which **stress** or **stimulate** the system in some way, i.e. which have the overall effect of **perturbations**..."

"Third, it is now understood that self-organization occurs in systems that have multiple **equilibria**... or several strata of potential **stability**".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"In view of these findings, self-organization can be explained on the general evolutionary principle of **fluctuations** induced either by **energy-flows** in the **milieu** acting on systems or by spontaneous **activity** by the systems themselves, inducing **chance variations** of **states**, some of which hit upon **levels of stability**" (1974, p.221).

The prerequisites for self-organization are somewhat differently stated (in accordance with the Brussels school of **thermodynamics**) by S.J. GAO and F.J. CHARLWOOD, as follows:

"Openness: The system must be open to the exchange of **energy, matter, information** with its **environment**;

"Non-equilibrium: The system must be in a **state** far from the **thermodynamic equilibrium**;

"Nonlinearity: there must be complex **non-linear** relations between the system's **components** (with multiple **feedback** and **feedforward loops**);

"Fluctuations: there must be microscopic **fluctuations** within the system which constantly test the **stability** of the macroscopic **state** of the system;

"Variation of environment: there is some structural coupling between the system and its **environment** and only the change of the **environment** can trigger the self-organization **process** in the system" (1993, p.58-59).

These conditions (save, possibly, the last one) do of course refer to an *already organized* system. There is a need to better connect the concepts of **autogenesis** and **autopoiesis** (and also **morphogenesis**) with **models** of self-organization, which describe either an incipient **process**, or a **dynamic equilibrium** condition.

The Swiss systemist E. SCHWARZ proposes a **meta model** of a "spiral of self-organization: ...the birth of a wide **variety** of systems displays a common succession of four states:

- 0) precursor tensions source of **instability**
- 1) noise or **fluctuations** (alea) triggering
- 2) a cascade of mutually provoked **events** (self-organization), which leads to
- 3) a new dynamically stable **structure-organization** of the system, followed by
- 4) a phase of actualization of the potentialities of this new system (**entropic drift** or trend toward the more probable)

"It must be noticed that the fluctuations in the alea sector do not always lead to a new viable **configuration** but, more often, end up with the **destruction** of the system or eventually with its maintenance with minor **adjustments**..." "A closer study of these **processes** shows that the **iteration** of such spiral **cycles** of self-organization and entropic drift generates a **long term** evolution toward **complexity** and **autonomy**, characterized by the successive appearance of six fundamental **loops** of increasing **abstraction**:

- 1- self-organizing **morphogenesis** (**positive feedback loops**)
- 2- **vortices** (recycling of **matter**)
- 3- **homeostasis** (**negative feedback loop**)
- 4- **autopoiesis** (self-production)
- 5- **self-reference** (between physical **structure** and logical organization), and
- 6- **autogenesis** (leading to **autonomy**)" (1998, p. 92)

2976

SELF-ORGANIZATION (Conditions for) ¹⁾

H. ATLAN states in the following way the conditions for self-organization:

"The initial **redundancy** must be high enough to start with, since it has the role of a potential for self-organization, to be reduced in the **process**.

"Some inertia must exist in the **response** of the system to **random perturbations** so that it is not going to be destroyed too quickly in order for the initial **redundancy** not to disappear right away. (A good example is that of liquid crystals and biological macromolecules where thermal **noise** can produce **changes** in conformation before it destroys the whole **structure** of the molecule, whereas the high repetitive order of crystals can exist only in one **form** and is completely destroyed almost at once when the "dose" of thermal **noise** – i.e. the temperature – reaches some **threshold**).

"Of course these are not sufficient conditions because the sufficient conditions have to do with specific **forms** of functional **organization**, i.e., with specific **functions** performed by the organized system, and giving a **meaning** to its **organization**" (1972).

In any case, as stated by M.B. HAWTON, self-organization becomes possible only if it initially has "... sufficient **preorganization** to run the first **cycle(s)** so as to generate the **information** which will be accumulated to organize future **cycles**. A machine can only become self-organizing through **operation**" (1974, p.87).

We are of course now burdened with the problem of **preorganization**. V. CSANYI introduced the useful concepts of **autogenetic system precursors**, **autogenesis** and **zero-system**, which shed some light on the subject. (1993)

2977

SELF-ORGANIZATION (Two meanings for) ¹⁾

There are two clearly distinguishable meanings for self-organization:

- 1- The progressive **process** by way of which a new **autopoietic system** with inherited and closely limiting characters constitutes its **repertory** of possible alternative **states**, all of them compatible with its **organizational closure**.

2. The progressive **emergence** of a system of a new type by **dissipative structuration** during a **process** of progressively overwhelming giant **fluctuations**, when over-abundant **energy** is at disposal.

An interesting comment on this second case by D. HERSHEY: "To describe the **behavior** of a self-organizing system we need some kind of index of the intensity of **energy dissipation**, which will provide us with a clue as to its organizing proclivity" (1986, p.6).

W. EBELING and R. FEISTEL add still a third type of self-organization, i.e. "dispersive self-organization (formation of a **soliton structure**)" (1982, p.11).

2978

SELF PRODUCTION versus SELF REPLICATION ¹⁾

- 1) Self-replication is (supposedly) the production by an **element** of another identical **element**.

- 2) Self-production is the **cycle** of reproduction of an organized system by itself.

Fenton ROBB states: "Self-replication" should not be mistaken for "self-production". The products of self-production of an **autopoietic process** may be quite different from these already comprising the system, if that is what is required to maintain its unity. A self-producing system may thus maintain its **process** by producing different **structures** with different **behaviors**. It may, in trying to maintain itself, produce novel **processes** and products, either with the present **structures** and **behaviors** or with new ones. For these reasons we shall not be able to distinguish simply by looking at their **structure**, or their **behavior**, **autopoietic systems** from those without that property. **Size, complexity** and **connectivity** may indeed be significant but do not of themselves provide us with diagnostic tools for the detection of **autopoiesis**" (1989, p.63).

Indeed, effective elementary self-replication seems to be a practical impossibility. The **element** would need a **template within itself** to make a copy of itself, and would thus be a **complex** system. Moreover, as the **template** must necessarily pre-exist, it must have been created somehow. Thus we are down back to the previous need:

- either of some kind of **meta-level recursivity**, as for example in biological systems, in which the genetic code seems to act as a **template**, but is provided by an hereditary mechanism, **recursive** at the species level
- or by evolutive **order from noise**.

The case of crystal **growth** within a saturated solution opens perhaps an interesting insight. Here, the **template** depends on the **lower level organization of complexity**, i.e., the **connection** mode of atomic electron shells within the molecule.

→ **Autopoiesis**

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

2979

SELF-REFERENCE¹⁾ – 2)

The **behavior** typical of a system able to reproduce its own **elements** and their specific **inter-relations** without any need for outside intervention (and even in spite of such interventions).

This **behavior** is typical of the **living systems**.

J. BEDNARZ Jr. writes (1990, p.58): "Their specific **mode of operation (organization)** is not meant to be understood in terms of referring to something beyond itself – which would be the case with the introduction of the concepts of **purpose, goal or function**. Rather it is closed, referring constantly to itself through the alternate (re)production of **components** and complex of **component-producing processes**. Whatever takes place within them as *living systems* – whatever is accomplished by their **organization** – does so "... as necessarily and constitutively determined in relation to themselves because their being defined as unities through self-reference (is) their manner of **autonomy**" (quoted from R.H. HOWE & H.von FOERSTER, 1975, p.XIII).

Self-reference is also a characteristic of **languages** (as shown by this very work!). This may lead to well known paradoxical statements and contradictions. (crf. the famous case of EPIMENIDES, the Cretan, stating that all Cretans are liars). This problem has been finally eliminated by WITHEHEAD's and RUSSELL's **Theory of types**, and also produced in **systemics** two successive very important offsprings: **2nd. order cybernetics** (of the **observer**) and **autopoiesis**.

Some authors state that self-referential systems are "closed". It should be understood that this means merely "**organizationally closed**": the system necessarily maintains numerous exchanges with its **environment**, but these do not affect its basic **identity**.

It is however to be noted that, in the words of N. LUHMANN (1995, p. 5): "...self-reference can only exist in an **environment** and only in relation to an environment. Or, with a different expression, that self-referential **operations** and system/environment differences mutually imply - and even more: logically imply each other".

And: "In the theoretical **situation** a new conceptual trinity sets new accents: it is the triad "**autopoiesis**, "**operational closure**", and "**structural coupling**". The concept of autopoiesis transfers the principle of self-reference from the structural to the operational level".

The system could not maintain itself without **activity** and its activity is in fact re-activity. It is experiencing with its environment through the "structural coupling" that feeds the autopoiesis of the system.

And, by the way, that saves it from entropic dissolution and /or **solipsism**

2980

SELF-REFERENCE IN LOGIC²⁾ – 3)

A.N. WHITEHEAD and B. RUSSELL definitively established in "Principia Mathematica" the necessity to exclude self-reference in logical statements, in order to avoid paradoxes and contradictions.

This excludes any "... self-referential utterances, statements, propositions, **descriptions**, etc.", as stated by R.H. HOWE and H.von FOERSTER (1975, p.1).

A curious result of this discovery is that **languages** are somehow **autopoietic systems**, able to produce only a limited – while enormous – number of statements, in accordance with their own combination **rules**, which by no means guarantee their logical soundness.

The self-reference problem is also related to **GÖDEL's Incompleteness theorem**.

→ **Logical types**

2981

SELF-REGULATION¹⁾ – 2)

The **process** by which a system is "able to modify its own **behavior** in order to enhance the **production of the desired output**" (after B. BANATHY, 1973, p.88).

It would seem that the self-regulating system is firstly able to maintain itself within its own **limits of dynamic stability**. According to E. JANTSCH, self-regulation is possible in a system "...in which **positive** and **negative feedback processes** would counteract each other sufficiently to warrant only a minimum of human intervention" (1975, p.272). This is obviously the case of many natural systems.

One could however conceive that a system could project itself out of its **stability** band precisely by trying to 'overdo' its performance: it could be the case of many **human systems**.

2982

SELF-REORGANIZATION²⁾⁽³⁾⁽⁴⁾

A more or less general re-arrangement of the **structures** and **functions** in a system.

Surprisingly, this **phenomenon** has not yet attracted a wide attention.

It is however a quite general one, of which numerous and varied examples are known: the molting of insects, crustaceae, and some vertebrates..., deep change in human **organizations** (re-engineering! - political and social mutations) and overall psychical (religious conversion for instance) or mental **transformations** (personal or at the **level** of so-called collective **paradigm shifts**).

Self-reorganization supposes the **decay** and dissolution of a specific ordering of the **elements** of the system and deep **perturbations** and even replacement of the existing **processes**.

However, this quite general loosening and unravelling of **organization** does not destroy some deeper plan or blueprint, which remains as a basic **template** for a new ordering.

CSANYI's **autogenesis models**, MATURANA's **autopoiesis** and PRIGOGINE's **dissipative structuration in systems far from equilibrium** could be useful in order to reach a better **understanding** and a good general **theory** of self-reorganization.

→ **Aura; Resilience**

2983

SELF-REPLICATING LOOP³⁾⁽⁵⁾

An **algorithm** that allows an **automaton** to produce copies of itself

Until now, such devices are merely **computing models**

M. SIPPER and J.A. REGGIA write: "Although various teams have created **cellular automata** in electronic hardware, such systems are probably too wasteful for practical applications: automata were never really intended to be implemented directly. Their purpose is to illuminate underlying principles of **replication** and, by doing so, inspire more concrete efforts"(p. 35, 1991)

The authors do comment about the possible creation of physical replicating **machines** and the disquieting question marks about their eventual relations with humanity (p. 35)

2984

SELF-REPRODUCTION²⁾

1. The capacity of a system to reproduce its own **elements** and the characteristic **network of interactions** between them.

This definition corresponds to the property of **autopoiesis** and its complement, **organizational closure**.

2. The capacity of a system to generate another system endowed with the same characteristics as itself.

This definition corresponds to J.von NEUMANN concept of self-reproducing "**automata**".

2985

SELF-REPRODUCTION

→ **Autopoiesis**

2986

SELF-SIMILARITY²⁾

Property of some **sets** such as each **part** at different **levels** is similar to the **whole**.

This is particularly the case with **fractals**, whose **forms** do repeat in a similar way through decreasing dimensional **scales**.

Some examples of self-similar sets are:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- CANTOR's set, obtainable by sequential suppression of the median third of a segment (a **process** that could theoretically be repeated ad infinitum, which is also the case in the following examples)

- von KOCH's curves
- SIERPINSKY's sieves and carpets
- PEANO's curves
- MENGER's sponges (see J. GLEICK, 1987)

Self-similarity is a powerful **algorithm** for **compressibility**. It is related to **chaotic attractors**, through **period-doubling sequences**.

Self-similarity is also the most important property of **holograms**.

J. GLEICK explains that self-similarity: "... implies **recursion**, **pattern** inside **pattern**. MANDELBROT's price charts and river charts display self-similarity, because not only do they produce detail at finer and finer **scales**, they also produce detail with certain constant **measurements**" (1987, p.103).

As GLEICK states: "The self-similarity is built into the technique of constructing the curves – the same **transformation** is repeated at smaller and smaller **scales**" (ibid).

The first and best known example of self-similarity is found in the **Golden Proportion** of the ancient Greeks. Self-similarity is also related to **chaos** and **renormalization**.

It was independently discovered by K. WEIERSTRASS as his continuous, non-differentiable **function** (See hereafter).

→ also: **ELLIOTT waves**; **Fields within fields**

2987

SELF-SIMILARITY in the WEIERSTRASS FUNCTION ²⁾

B. WEST and A. GOLDBERGER explain: "His **function** was a superposition of harmonic terms: a fundamental with **frequency** Ω_0 and unit **amplitude**, a second **periodic** term of **frequency** $b\Omega_0$ with **amplitude** $1/a$, a third **periodic** term of **frequency** $b^2\Omega_0$ with **amplitude** $1/a^2$, and so on. The resulting function is an infinite series of **periodic** terms, each term of which has a **frequency** that is a factor b larger than the preceeding and an **amplitude** that is a factor of $1/a$ smaller. Thus, in giving a functional form to CANTOR's ideas, WEIERSTRASS was the first scientist to construct a **fractal function**" (1987, p.360).

The WEIERSTRASS function offers some singular properties: "Because of the infinite **layers** of detail, one cannot draw a tangent to a **fractal** curve, which means that the function, although continuous, is not differentiable" (ibid).

Its **mode** of construction implies that the curve is self-similar at any **level**. It also can be properly interpolated in a continuous way, however acquiring more and more closely defined values at microscopic **levels**.

At any chosen **level** the curve is a **fluctuation** of the more macroscopic **level** and the median of the immediately inferior **level** of **fluctuations**.

Moreover, any WEIERSTRASS function has its proper measure of self-similarity, in terms of **frequency** and **amplitude**, "which is precisely the **fractal**, or HAUSDORFF dimension: $\log_n a / \log_n b$ " (ibid).

The WEIERSTRASS function is a "**scaling** relation, often called the **renormalization group transformation**" (ibid).

Its analogy – unfortunately rather imperfect – with embedded complex cyclical **processes** is striking.

See: "**equilibria (levels of)**"; "**cyclical or periodic**".

→ See also "**Resonance**"

2988

SELF-SIMPLIFICATION ²⁾

This is an evolutionary **process** postulated by H. PATTEE, as indispensable to complement mutation by **random search** and subsequent **selection**, which must be considered in his opinion as quite an insufficient explanation for **evolution** (1972, p.39).

PATTEE sees self-simplification as a jump from one **level of complexity** to the next higher one, more or less akin to SIMON's **Hora and Tempus** metaphor.

It implies **self-description** through a **code**, i. e. "... a new **hierarchical level** of (self) **description** which selectively ignores the trapped details at the lower **level**" (p.39).

Self-simplification could result, through the steering power of such a **code**, from the appearance at the higher **levels** of specific (i.e. **constrained**) **networks of interrelations** between very numerous **elements**. In this way **composite systems** could conceivably produce **complex systems**, as for example in the social phase of the amoeba *Dictyostelium discoideum*.

It could also possibly correspond to N. ELDREDGE and S. GOULD concept of punctuated **evolution**, as well as to biological ordering through genetic **codes** and social **order** through **values** and **norms**.

2989

SELF-STABILIZATION ^{1) - 2)}

The capacity of a system to pass from **growth** to **steady state**.

No **dynamic system** can survive for long **time** if it cannot control, limit and finally stop its own **growth**, because it finally crosses a **threshold** where neither its internal **structure** maintains anymore its **coherence**, nor its **environment** remains able to feed it its needed **inputs**.

Genetic **controls** (not yet clearly understood) take care of self-stabilization at the biological **level**.

The stabilizing devices in societies are still more enigmatic and would constitute a rich ground for systemic **inquiry**.

The subject seems closely related to **autopoiesis** and **organizational closure**, as well as **morphogenesis** and **morphostasis**.

2990

SEMANTIC AMBIGUITY ³⁾

Any problem of **meaning** interpretation arising from imprecise use of **interconnections** between **semantic units** in a **semantic net**.

E. BUCHBERGER gives the following example:

"I see the man with the hat"

"I see the man with the binoculars"

Only the semantic or the observed context would suppress the **ambiguity** of the second sentence. For another type of **ambiguity**, see "**semantic unit**" (1987)

2991

SEMANTIC CLOSURE ^{3) - 5)}

Self-catalysis of language and **autopoiesis** in its uses.

"An **entanglement** of symbolic **controls** and material **constraints** which is closed on its **semantics**". (H. PATTEE, 1982)

Semantic closure results of the **interactions** between basic **constraints** in a **language**.

H. PATTEE, who introduced this quite abstract notion, applies it to any kind of **languages**, starting with molecular biology. He writes: "A generalized **language** might therefore be characterized in a simple chain of **constraints** that controls the construction of complex **patterns**" (in KLIR, 1991, p.583-85).

In a human language for instance, there are phonetic **constraints** at one **level** and orthographical, grammatical and syntactical ones at other **levels**.

Semantic closure is characteristic of **self-reproducing organisms**. L.M. ROCHA comments: "The principle of semantic closure entails symbolic **messages** that code for compounds of material **parts**, which will themselves organize" (1996, p.380)

→ hereafter.

2992

SEMANTIC CONSTELLATION (SeCo) ¹⁾²⁾⁴⁾

"Dynamical **networks** of **elements/processes** extending transversally through different **levels** of the mind-body-psyche system"(C. HARDY, 2001, p. 37)

"These networks...are created through the interplay of experimental uniqueness, cultural influences and genetic **constraints**...

"The SeCo can thus range from a highly personal and idiosyncratic **organization** (artistic skill, specific feelings, etc...) to one that is partly constrained by social **consensus** (driving, playing tennis, etc...)" (Ibid.)

The Semantic Constellation concept is close to the **mental frame** concept (WARFIELD) or the **frame of reference** one (FRANÇOIS). All of these try to explain how we construct, use, and sometimes modify our mental **structures** (or possibly our neuronal connexions in our cerebral cortex)

HARDY also observes that in a SeCo, "the mode of **interaction** between levels and processes cannot be simply hierarchical" (p.39)

She states that: "...the SeCo – as dynamical network is...self-organized" (p. 40) and that "a healthy psyche is characterized by SeCos that remain labile" (sic)

Also: "...one aspect of SeCo **dynamics** lends itself well to VARELA's concept of "mutual constraints" (Ibid.)

These constraints are biological, or interpersonal, or social. Moreover "these organizing factors are not intrinsic, but mostly **historical**" (Ibid.)

Training, learning and generally **education** give themselves in that historical dimension.

In a similar way, "in a specific SeCo, integrative and conative **processes** act as predominant organizational forces in the **configuration** and **transformation** of the SeCo " and "through the need for understanding (the attribution of **meaning**) and a need for **coherence** "the SeCo turns operative as "intentions and anticipations seem quite pervasive" (Ibid.)

→ **Semantic Field- Webs (Multilevel)**

2993

SEMANTIC CORRELATION SYSTEM ¹⁾²⁾³⁾

"A **methodology** for **information** processing systems based on the possibility to compute semantic proximity between texts in reference to thesauri" (G. MINATI, 1994)

Minati adds: "Such a **computation** takes place by considering words, **structures** of words, structures of structures in specific **contexts** and by considering semantic correspondences between words, structures, structures of structures and conditional structured synonyms"

Such a computation could be very helpful to reach a more integrated **understanding** of the general nature and **meaning** of the systemic (and cybernetic) **meta-language**.

2994

SEMANTIC FIELD ²⁾³⁾⁴⁾

The **network** of all the concepts and ideas (expressed in words) as related to one chosen specific concept.

V.V. NALIMOV shows as an example, the set of **connections** that can be constructed around the concept of freedom (1982, p. 214-219)

In fact, Nalimov's **graphs** are only connected and weighted listings, i.e. a kind of static (and statistical) census.

A true semantic field should be multi-connected. It could for example be theoretically possible to draw, under the form of a very complex graph, the multiple interconnections of all the terms in this encyclopedia. We would of course obtain in this way a gigantic and hyper-complex map, whose global understanding would be excessively difficult.

However **nodes** that would appear in the map, would make it easier to catch its general **meaning**..

C. HARDY writes: "According to Semantic Field Theory, the basic dynamic of the mind is a connective, dynamic, instantiating spontaneous **linkages** between **elements/processes** within **Semantic Constellations** or between these" (2001, p. 41)

HARDY, who proposes the semantic field concept, adds that "in these dynamical **networks**...the most pervasive interactive process is that of inter-influences, which VARELA calls "reciprocal influences".

Of course "...there often exist global **patterns** that harmonize the system..." (such as **values, goals, feelings, etc...**)

HARDY speaks of an "ordering principle", which is of course a basic feature of any field.

However she does not describes this principle in detail. One could imagine that it resides in the reciprocal **constraints** resulting from the nascent and growing **interactions** among elements and processes.

About " **values, goals, feelings, etc** "Nalimov concedes that any dictionary should be considered " as a filter given by our **culture**" (p. 214). We would add "...and by our viewpoint. For ex. It is obvious that the concepts of " system" and " feedback" are the basic organizers of the specific semantic field reflected in this Encyclopedia...and are moreover as such rooted in Western culture

→ **Autogenesis; Determinism (Chaotic); Semantic Constellations; Sociality; Supremacy of the complex; Webs (Multilevel); Zero System**

2995

SEMANTIC FILTER ³⁾⁵⁾

G.L. FARRE states: "A semantic filter results form the projection of a **semantic matrix** onto some corresponding type of **observation space**" (1998b, p. 266)

For example, while the semantic matrix of the meteorologist and the one of the climatologist have many common features, they differ:

- 1- by the **time dimension** of their research
- 2- by the way they interconnect the results of their **observations**

FARRE expresses this in the following sentence: "Thus construed (Note:i.e. on the base of a specific **semantic matrix** mediating into a specific **language** by a **syntax**), the semantic filter effectively defines the *universe of discourse U* of the language, which is the **domain** of *what* the language is about, what it describes and what the operational end of the semantic filter is designed to probe: the observations are thus theory laden" (p. 267)

2996

SEMANTIC MATRIX ³⁾

"The **process** by which a **context** independent conceptual **structure** is brought to bear on inherently local **observations**" (G.L. FARRE, 1998 b, p. 266)

Systemics and cybernetics constitute wide transdisciplinary conceptual structures that can be used to process any kind of observations in a specific discipline in the sense to interrelate them at their own disciplinary **level** and, on the other hand, to other types of observations at the same or different levels made in the **frame** of other disciplines

Any semantic matrix produces a specific **semantic filter**

2997

SEMANTIC NET ³⁾

A **network** of **meaning** bearing **elements** (or **nodes**) interconnected through specific (i.e. specified and oriented) **links**.

Any **language** is a semantic net. The systemic and cybernetic **language**, object of this work, is an example.

M. BODEN makes some interesting observations: "The concept of semantic net originated in psychology. It depicts human **memory** as an associative system wherein each idea can lead to many other relevant ideas, – and even to 'irrelevant' ideas, linked to the first by mere coincidence... A semantic net consists of **nodes** and **links**. The **nodes** stand for specific ideas, while the **links** – whereby one idea can be accessed from another – represent various types of mental **connections**... The '**meaning**' of an idea represented within a semantic net is a function of its place in the system. It involves not only the **node** specifically labelled for the idea in question (*violet*, perhaps) but also the **nodes** that can be reached, directly or indirectly, from that **node**... Adding a new **node** will implicitly affect the **meaning** of all the existing ones..." (1990, p.95-6).

The semantic net **model** represents a **conceptual space** and is closely related to **connectionism** which "associative **memory**", grounded in both **meaning** and **context**" (p.119).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2998

SEMANTIC NOISE³⁾

1. "Any feature of the **message** that reduces the sharpness of the selective operation on the required subspace." (D. Mac KAY, 1969, p.74)

This somewhat abstract formulation means that, as any question specifies an area in which required **information** helps to make **meaning** more precise, anything that confuses or obscures that **information** is "noise" in a sense akin to the perturbing noise in a physical **channel** of **communication**.

Semantic noise, however, is different from irrelevant **information**.

2. "**Ambiguity** in the denotation or connotation of a **message**" (R.L. ACKOFF and F.E. EMERY, 1972, p.182).

These authors state: "A **message** may be misinterpreted – that is, *B* responds to the wrong thing – and still produces the type of **response** intended" (Ibid).

Misinterpretation is the result either of sloppy semantics from the sender (who does not consider the possibility of **ambiguity** inherent to the **situation**) or imprecision in the **code** itself.

In some critical cases, the **message** cannot be interpreted if the **situation** is not well known.

2999

SEMANTIC PRIMARY⁵⁾

"A signification bearing unit that cannot be further decomposed" (E. BUCHBERGER, 1987, p.79).

The existence of truly primary semantic units seems doubtful to this compiler. As an example, even very basic systemic and cybernetic concepts as **energy**, **matter**, **space**, **time** or **information** and **entropy** are not the result of a "decomposition" and cannot be defined without reference to other units.

This doubt is also expressed by E.von GLASERSFELD: "Experience has shown that one rarely succeeds in isolating and defining a semantic **element** the first time it crops up in an analysis; it is only when the same **element** is found to be relevant in the analysis of other verbs that it gains contour and becomes more satisfactorily defined" (1988, p.20).

The same author speaks of complexes of "semantic nexus" (p.39).

However, the semantic primary concept is certainly useful in classical **Artificial Intelligence programming**.

3000

SEMANTIC PROCESS³⁾

A **cognitive process** that tends to evoke a supposedly **adaptive behavior** in some **situation** deemed analogous to some formerly memorized one.

F. and P. LAVIGNE distinguish two fundamental steps in the semantic process:

- 1) to faithfully perceive and semantically recognize **events** in the **environment** and
- 2) to dynamically anticipate possible future **events** (2000, p. 5)

They explain how formerly stored **associations** between some frequent similar **sequences** of events prepare the **recognition** in new situations of also seemingly similar sequences, yet incomplete.

This focuses the attention on the **probability** that the current sequence should lead to similar (or possibly dissimilar) results. This **anticipation** will then generate some adaptive behavior (Ibid)

3001

SEMANTIC REACTION³⁾ – 4) – 5)

"The psycho-logical reaction of a given individual to words and **language** and other **symbols** and **events** in connection with their **meanings**, and the psycho-logical reactions which become **meanings** and relational **configurations** the moment the given individual begins to analyse them or somebody else does that for him" (A. KORZYBSKI, 1950, p.24).

Let us observe that the author writes "psycho-logical", with hyphen, to emphasize the existence of both aspects in psychological attitudes. Semantic reactions are related both with the emotional and the mental **levels** in the nervous system, with a natural **dominance** of the former one.

KORZYBSKI comments: "It is of great importance to realize that the term "semantic" is *non-elementalistic*, as it involves conjointly the "emotional" as well as the "intellectual" factors". and... "The term *semantic reaction* will be used as covering both semantic reflexes and **states**" (p.25).

The basic point about semantic reactions is that **meanings** are never totally objective and absolute. They depend on the specific organizational psycho-logical **closure**, as well as of the cultural **environment** of the individual.

The Cross for example is a **symbol** revered by Christians, but may evoke negative reactions from a Muslim and no definite reaction at all from heathen who never heard about Jesus. Moreover, these reactions are automatic, not submitted to any voluntary **control**.

Semantic reactions can be very dangerous from the psychopathological viewpoint. KORZYBSKI proposed a whole psychotherapy based on the reeducation of semantic reactions in his work "Science and Sanity". Unawareness of semantic reactions also implies a great potential sociocultural risk, since they can easily be manipulated by ideologues, agitators and schemers.

3002

SEMANTIC SPACE³⁾

The global **field** of **meanings** of any word as it is used within the **limits** of a given **language**.

CH. HENRY thus explains this concept: "... words take their **meaning** in part from other words around them in a sentence or paragraph or, one might add, any verbal **construct** that supplies **context**" (1992, p.695).

Moreover "... the non-literal **meaning** of a word is governed in large part by its **context**" (Ibid).

It could even be said that words within a sentence or a discourse lose a part of their **identity**, just as electrons in atoms, atoms in molecules, molecules in **cells** and individuals in societies.

3003

SEMANTIC UNIT³⁾

"A whole group of words or even of sentences acting together, rather than single words acting in isolation." (D. Mac KAY, 1969, p.29)

This definition may be extended towards nonspoken or written expressions. A red stop **sign** at a crossroads or the ominous roar of thunder, or for a mouse in a field the shape of a sparrowhawk in the sky are somehow bearers of **meaning for whom has been trained to understand them** (see "**semiosis**").

On the other hand, any **language** may be considered as a matrix of countless semantic units.

As noted by G.M. WEINBERG, not only the **interrelations** between words, but even implicit **syntactic** and semantic **knowledge** by the users of the **language**, are conditions of correct interpretations and suppression of ambiguities. He submits the following amusing example:

"TIME FLIES LIKE AN ARROW"

"FRUIT FLIES LIKE A BANANA" (1975, p.65)

and uses it to show the difficulties in resolving ambiguities in computer **programs**.

3004

SEMANTICS³⁾ – 5)

"The theory of the relations between the **signs** and the **objects** symbolized by them (**designata**)" (D. GERNERT, 2000 a), p. 155) "...and more specially, the study of the **meanings** of words..."

The study of the **meanings** of words, of their use in **languages** and the adequacy of this use for the **representation** of reality and as a means of **communication**.

Semantics is that part of **semiotics** which is restricted to the spoken or written **signs**.

3005

SEMANTICS (General) ³⁾ - ⁵⁾

A psycho-logical general theory of the relations between **perceptions**, physiological **reactions** to them, mental elaborations and resulting effective and verbal **behavior**.

General semantics was introduced by A. KORZYBSKI, in his famous work "Science and Sanity" (1933). It covers a much wider area than what is commonly known as semantics, including important insight in logics, **epistemology**, physiology, psychology, psychiatry and **learning**.

Its global approach is closely related to **systemics**, as for example to von FOERSTER concept of **observing systems**.

KORZYBSKI advocates for a psycho- and even physio-semantic re-education in order to avoid conceptual disorder and confusion, leading to mental alienation, at individual and social level. He developed the concept of **non-identity** of **elements** and systems in space and time and insisted on the danger of **spurious identifications**. This includes the necessity to avoid confusion between our **abstractions** and concrete reality, a sine qua non condition of mental equilibrium and health.

The main features of General Semantics are as follows:

- **Knowledge** is circular: We must distinguish: "between the inherent **circularity** of "human **Knowledge**", which must start with **sets** of undefined terms, and so start with **some knowledge**; and circular definitions or explanations which define or explain nothing" (1950, p.759).

Progressively deepen the **contents** of the unavoidable basic tautologies is not the same as become unconsciously and passively ensnared in tautological circles, that, through verbalizations without new **contents**, block us from any progress toward **understanding**.

- Taking conscience of the different **orders of abstraction**: KORZYBSKI warns against what he calls the danger of "objectification" of words, remembrances, etc..., i.e. granting a factual reality to mental **constructs**, or burden **perception** of reality with **abstractions**. For example, "**dynamic stability**" does not exist independently from concrete and observable systems which are dynamically stable, *each in its own way*.

Moreover, we should take conscience of the various **levels of abstraction**. It is never possible to describe completely the **fact** or **event** in itself: From my dog "Max" as I see it at this fleeting moment, to the generalized abstraction "living being", there is a whole **scale** of more and more abstract "**labels**". In KORZYBSKI's words: "... the most usual **identification** of different **higher order abstractions** appears as the confusion of inferences and inferential terms with **descriptions** and descriptive terms" (p.443).

KORZYBSKI created a kind of mnemotechnic **model** of **scales of abstractions**, the so-called "**structural differential**" (fig. p.558), which is very useful to train the mind for correct acknowledgement and differentiation of the various **levels of abstraction** (p.393-8).

- **Non-identification**: KORZYBSKI advises training oneself in non-identification as a way to psychological and mental sanity. He considers abusive **identifications** as the root of multiple psychological and socio-political problems. Only non-identification prepares us to perceive and understand **new** and unexpected **behavior** in systems, resulting from **interactions** between their **parts**, or with the **environment**, that had never been observed in the past.

Non-identification also prevents us to stick unwarranted significance to some **events** because we tend to give them the same **meaning** that we gave to former **apparently similar events**.

Finally, **radical** non-identification helps us to understand that **every event, fact or situation** is fleetingly **unique** in **space-time** and that, consequently, generalizations should be avoided or made with utter care.

- **Semantic reactions**: According to KORZYBSKI we live our lives in emotional subjective **levels**, generally unexpressed, but not in verbal **levels**. These are merely auxiliary, sometimes useful (when well adapted to circumstances), and sometimes harmful (when otherwise). This is a result of our ignorance of our own semantic reactions which burden our ways to communicate with others.

KORZYBSKI thus proposes to "break the old elementalism" and replace psychology by "psycho-logics" to emphasize the interplay between the emotional (unspeakable, or at least unspeakable) **level** and the mental one (p.23-24). This type of problems was later on further explained by the French biologist H. LABORIT (1954, 1970, 1976).

KORZYBSKI's ideas are moreover consonant with von FOERSTER's **2nd order cybernetics** and with MATURANA and VARELA's **organizational closure**.

- **Time-binding**: Man, and probably all living beings to a lesser extend, are somehow connected with themselves through **time**, by way of physiological and nervous devices (1950)

In "Science and sanity", KORZYBSKI develops various practical training **methods** to re-educate **behavior** in a better psycho-logic way.

→ **Non-identity**

3006

SEMANTICS (Pathological) ³⁾

H.von FOERSTER persistently denounces the sloppy use of terminology in systems and **cybernetics**.

He gives some glaring examples:

"When engineers talk about a computer's **"memory"**, they really don't mean a computer's **memory**; they refer to devices or systems of devices, for recording electric **signals** which when needed for further manipulation can be played back again. Hence, these devices are **stores** of **storage** systems... The content of these **stores** is a **record**" (1981, p.236).

As von FOERSTER once observed in a lecture, we thus come to believe erroneously that the electronic engineers know what **memory** "is" and, adopting the false **analogy**, we look for **stores** of **data** in some precise place in the **brain**.

Another example is the term "**problem solver**" applied to computers: "Of course, they are no **problem solvers**, because they do not have any problem in the first place. It is *our* problem they help us solve like any useful tool, say, a hammer which may be dubbed a "problem solver" for driving nails into a board. The danger in this subtle **semantic** twist by which the responsibility for **action** is shifted from man to a **machine** lies in making us loose sight of the **cognition** problem" (Ibid., p.237).

Another example widely developed by von FOERSTER are the numerous semantic abuses on the term "**information**", principally originated in the common delusion that **data** are **information**, while only their **understanding** and ordering by our **brain** in **interrelations** clustered in **reference frames** becomes **information**.

3007

SEMI-LOGARITHMIC GROWTH

→ **Logarithmic growth (Semi); Optimum (Dynamic); Ratio scale**

3008

SEMIOCHEMICALS ⁵⁾

A general term for hormones and **pheromones**. The neologism is introduced by T. STONIER (1997) and considered by S. BRIER as "not a bad term"

Other biochemicals as for example Adenosine Triphosphate (ATP) and ADN and ARN could, it seems, be added to the list. So could the intersynaptic chemicals in the **nervous system**.

Generally speaking, the new term aims at conveying the **information transmission value** of these chemicals and their role in bi-and multiple **relationships** and, as a result, as **agents** of **sociality**.

→ **Infon**

3009

SEMIOLOGY ⁵⁾

The science that deals with the **significance** given to **signs**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

From the systemic viewpoint, semiology is closely related to the way our **perceptions** lead to the construction of **networks** of interconnected and coherent **meanings**, in the **brain** and nervous system.

According to E. BENVENISTE, the semiotic **sign** is recognized before it can be used. Semiotics thus precedes **semantics**, which results of an activation of the **signs** within a **language**.

3010

SEMIOSIS²⁾

C.S. PEIRCE, quoted by U. ECO, wrote: "By semiosis I mean an **action**, an influence, which is, or involves, a **cooperation** of three subjects, such as a **sign**, its **object** and its interpretant, this tri-relative influence not being in any way resolvable into **actions** between pairs" (1979, p.15).

Semiosis tends to be an ongoing **process**: "... in order to establish what the interpretant of a **sign** is, it is necessary to name it by means of another **sign** which in turn has another interpretant to be named by another **sign** and so on" (Ibid, p.68).

Semiosis thus parallels somehow the ever-branching circulation of **meanings** within a **semantic network**.

Note: Ch.S. PEIRCE spelled "semeiosis" in lieu of "semiosis". The same observation has to be made about "semiotics" or "semeiotics"

3011

SEMIOSPHERE²⁾⁴⁾

The whole set of living **organisms** able to communicate through their interpretation of a variety of **signs**

GOPPOLD comments: "In the diction of MATURANA (1987) and LUHMANN (1993), **social systems** and proto-social systems arise in the behavioral **coupling** of organisms, which is another way to look at the Semiosphere.

The Semiosphere is the comprehensive concept for all *ontogenetic pattern transmission in the biosphere*. In the case of organisms with higher neuronal systems, like mammals and birds, the behavioral coupling is effected by **neuronal resonance**" (2000, p. 108)

Even more archaic **communication** through **pheromones** or other biochemical products takes place in **ecosystems**. In these cases the **behavioral coupling** is also obvious. In a somewhat dubious way, we could possibly speak of proto-semiotics

3012

SEMIOTIC BIOLOGY

→ **Biosemiotics**

3013

SEMIOTIC LIBERTY¹⁾

Degree of freedom of a system in relation to its **constraints** (D. Mac KAY, 1969, p.48)

"The relative extension of the **code** and the logical possibilities for combination within the **message** do control the informational possibilities of the system and thus, its organization" (p.48).

3014

SEMIOTICS^{3) - 5)}

"The study of **signs** and **symbols** and the way they program **behavior**" (J.Z. YOUNG, 1974, p.298).

Semiotics was introduced by C.S. PEIRCE, who defined it as "the necessary **laws of signs**".

YOUNG adds that **signs** can be "...transmitted as **language** or by gesture, smell, touch, or in any other way" (Ibid).

Ph. GUDEMI explains PEIRCE semiotics as follows: "In semeiotics (sic), something can serve as a **sign** of something else by being an **icon**, an **index** or a **symbol**...An icon serves as a sign by resemblance to something else, like a portrait to the person portrayed. An index serves as a sign by pointing to other things, which are associated with it in a potential "causal" manner, like a cloud to possible or actual rain (The use of **causality** is meant mainly as illustration, since the philosophy of **causality** is itself full of a number of vexing **issues** and semeiotics should not be held hostage to it). And a symbol is an agreement that something will stay for something else, independently of any iconic or indexical **relationship** the one has to the other; words in human **language** are the most typical exemplar of the symbol" (2000, p. 134)

(Let us remember the ironic MAGRITTE's painting titled "This is not a pipe", precisely *representing* a pipe).

Gudemmi's paper also explains very clearly other Peirce's terms, among them: firstness, secondness, thirdness and interpretant. He relates Peirce's **phenomenology of experience** to MATURANA and VARELA's **structural coupling**.

Note: For various important papers about Peirce, see KAUFFMAN, L.H. and BRIER, S. (2001)

D. GERNERT offers the following synthesis of the role of Charles W. MORRIS in the history of semiotics: "Starting mainly from some specific parts in the extensive work of Charles S. PEIRCE (1839-1914), the American philosopher Charles William MORRIS (1901-1979) was the first to formulate semiotics, the theory of signs, as an explicit and elaborated concept (1938). In modern terms semiotics can be defined as the scientific theory of the characterization, utilization and efficiency of **signs**

"MORRIS gave the following subdivision, which has become influential since the early days of analytical philosophy. Semiotics consists of:

- **syntactics**: the theory of relations between the signs
- **semantics**: the theory of the **relations** between the signs and the **objects** symbolized by them (**designata**)
- **pragmatics**: the theory of the relations between the signs and their users

"Furthermore, MORRIS made a distinction between general (or pure) semiotics as a neutral and fundamental theory, and descriptive semiotics- the latter term denotes the utilization of the theory to "concrete instances of signs", or, in other words, to a specific field of application" (2000, p. 155)

GERNERT observes that "descriptive semiotics covers a great variety of fields like linguistic semiotics, medical semiotics, architectural, musical, theatre and film semiotics, zoo semiotics, and phytosemiotics" (Ibid)

This is the bridge between syntactics and semantics

3015

SENESCENCE in complex systems^{1) - 4)}

H.T. ODUM states: "senescence is a property of the compact and **complex**" and adds that those: "Associations which have monolithic **structures**... develop senescence". Such **structures** "... do develop where power **flows** are highly concentrated" (1971, p.143-144).

As examples he gives crowded barnacle **growths** and overcluttered and dilapidated urban neighborhoods.

Senescent **complex systems** undergo destructive crisis which allows for their renovation or replacement.

It is however not clear how the concept (originated in **ecology**) could be applied to strongly **integrated systems**, as for example an individual living being.

3016

SENSIBILITY TO INITIAL CONDITIONS^{1) - 2)}

"The property of a system, or some K part of it in the **phase space** X such as if, starting from any initial position in K, **fluctuations** as small as wished end up generating macroscopic **divergences**" (after A. DOUADY, 1992, p.17).

RUELLE and TAKENS established that, in **chaotic systems** "two **trajectories** of the **attractor**, initially as close to each other as wanted, finally always diverge from each other. This **divergence** increases even, on average, exponentially with **time**".

..."Thus the **trajectory** actually followed by the system depends crucially from its starting point." (P BERGÉ, Y. POMEAU & C. VIDAL, 1984, p.111).

This is a basic difference between **stable** and **unstable systems**.

In conservative systems, the **trajectories** remain confined within closely determined **limits**, characterized by an **asymptotic attractor** or a **periodic** one (**stability** in the sense of LA-GRANGE). The **behavior** of such systems can be predicted.

However, they are not the rule, but well the exception. Conservative systems depends on no more than two initial and independent conditions, in which case a **chaotic behavior** cannot appear.

On the contrary, with three or more incommensurable initial conditions (or **degrees of freedom**, or **order parameters**), **chaos** appears, characterized by alternatively growing and contracting deformations of the **trajectories**, the deformations being limited by the most extreme values that can be taken by the physical **variables**. Thus, global **determinism** is not lost, but becomes concealed behind apparently incoherent **short term variations**. In a sense, the system seems to lose the precise "**memory**" of its past, retaining only a kind of statistical (or **ergodic**) "**memory**". This is related to the reciprocal influence of the various conditions on each other and to the impossibility of instantaneous transmission of their **effects**, at a distance. The global **determinism** does not wholly disappear, but at any instant, becomes locally fragmented and, due to **time lags** can never be fully recovered.

3017

SENSITIVITY^{1) - 2)}

The minimum **input** needed to produce an **output** in some **process**.

The **concept** is widely used in **simulation**, as for example in **Systems Dynamics**.

Sensitivity analysis aims at discovering how much the estimates used in a **model** can vary without impairing the **outputs** validity.

3018

SENSOR¹⁾

Any **element** or **subsystem** in a system which picks up some kind of **information**.

In natural systems, the sensors are, of course the sensorial **organs**, attuned to some specific kinds of **inputs** as for example visible light or sound waves.

We have learned however, to amplify considerably the range of our **perceptions** by creating numerous and very varied artificial devices that are able to pick up many **inputs** to which our biological sensors remain insensible, either because the possible effects are too weak or too small, or in inaccessible **ranges** (as for example herzian waves or X-rays).

These devices are equipped with appropriate optical, mechanical or electronic sensors.

P. CARIANI remembers that "In the late 1950's Gordon PASK constructed several electrochemical devices having emergent sensory capabilities. These **control systems** possessed the ability to adaptively construct their own sensors, thereby choosing the relationship between their **internal states** and the world at large... PASK's devices have far-reaching implications for **artificial intelligence**, self-constructing devices, theories of **observers** and epistemically-**autonomous agents**, theories of **functional emergence**, **machine creativity**, and the limits of contemporary **machine learning paradigms**" (1993, p.19).

It could be added that no **autopoietic system** can be conceived that should not have been able at its beginnings to construct its own **emerging self-organized** sensors.

3019

SENSORY MOTOR-LOOP¹⁾²⁾

The circular relation between motor **functions** and sensory apparatus that characterizes our interpretations of our **environment**.

H.von FOERSTER says: "In 1895 POINCARÉ was, I believe, the first to connect movement, or the change in position with the change in **perception**, and who said: "One interprets the other". that is, through my motor functions I interpret sensory **input**, and my sensory apparatus interpret motor inputs

" He adds that PIAGET found that in children "...their motor **activity** interprets their sensorium; that motoric changes their sensations; that a **relationship** exists between the **change** in body position and changes in sensation. the coupling of these two allows for the construction of what I claim to be the **object** (in German: "Gegenstand") the one that stands up against (again in German: "ent-gegensteht") (p. 21, 2002)

The sensory motorloop seems thus to be the necessary basic condition for any **constructivist** view.

3020

SEPARABILITY¹⁾

In most cases it is quite difficult to clearly separate a system from its **environment**.

Using the enterprise in its **environment** as an example, St. BEER states: "... these two systems are not absolutely separable, they do not have absolutely clear-cut **boundaries**. One of the reasons for the problem of separability is that each is influenced by a **set** of **coenetic variables** to be found in the world at large" (1968, p.391).

3021

SEPARABILITY AXIOM^{1) - 3)}

Any **operation** should be completely independent from the performing **operator**.

This axiom of disjunctive logic is the bedrock of the analytic **Cartesian method**.

Its validity is however growingly curtailed in modern science, since it is now evident that, in many (if not in all) cases, it is not possible to satisfy the separability condition.

The **operator** is most frequently an active **agent** in the **operation process**. It is merely acceptable to neglect his/her influence when he/she is only an **observer** whose influence is insignificant in **space** or **time dimensional domain**.

Systems science in particular needs a conjunctive logic. In J.C. LUGAN's words: "... the **organization**, the organized **object**, the **organization's** product and the organizer cannot be separated" (1993, p.91).

Examples abound, from the quantic to the **human systems level**.

3022

SEPARATRIX²⁾

The boundary between **basins of attraction**, i. e. between two zones of **stability** of different characteristics.

R.H. ABRAHAM and C.D. SHAW state: "By definition, separatrix points are not in **basins**. Thus, they belong to the insets of **limit sets** which are not **attractors**, the **exceptional limit sets**" (1987, p.549).

As a result, the separatrix corresponds to the critical **threshold**, the locus where **bifurcations** can take place.

As stated by St. KAUFFMAN, in two dimensions, the separatrix is a line (i.e. one-dimensional), and in three dimensions it is a surface (i.e. bi-dimensional) (1993, p.176-7).

3023

SEQUENCE (Evolutive)^{1) - 5)}

The successive **states** of an **ecosystems transformation** after a **disturbance**.

S. REICE states: "**Disturbance** is a reinitializing step in the successional development of a **community**. Different **disturbances** remove different species to different degrees. Therefore, the particular **response** of the **community** is likely to be a unique successional sequence" (1994, p.428).

In global economic or social **communities**, the same rule is applicable as to the removal of some systems and their subsequent replacement or reappearance.

3024

SEQUENCE (Life)¹⁾

The successive **states** of a system from its beginning or birth to its final dissolution.

Very different types of systems show quite similar life sequences.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

When a new system or type of system appears it starts to grow or multiply slowly. However the **growth process** generally gathers momentum, accelerating until some kind of **negative feedback** appears, which first decelerates **growth** and later on stops it completely.

Thereafter, the system enters in its maturing phase and becomes **homeostatic** (or acquires **dynamic stability**) and starts to fluctuate between a lower and an upper **limit of stability**.

After a more or less long time, the system loses its adaptative capacity (generally rather suddenly) and since it is not anymore able to maintain itself, its **elements** escape from its **control** and the system disappears or dies.

These life sequences have been observed in very diverse settings, as for example:

- in individual living beings
- in animal and vegetal species
- in the production of ecological systems
- in business or industrial firms
- in economic sectors
- in political systems

(See for example F. MEYER in his "Problématique de l'Evolution" (1954) or Howard T. ODUM's "Systems Ecology: an Introduction" (1983).

The life sequence can be explained in the following way, at least in general terms:

1. The new system has a significant potential for innovation, due to its new combination of **information** (genetical or technological for example).
2. However, it must first learn and adapt to its **environment**. Thus its beginnings are slow and sometimes difficult. In some cases it must undergo wide restructuration during this period.
3. When sufficiently trained or adapted, it becomes able to develop its potential for **growth**. If it is really innovative, it will find for itself an important **niche** in its **environment**, many times at expenses of older systems.
4. After a period of nearly unfettered **growth** it starts to meet a growing resistance, from older competitive systems which try to regain ground, from new ones which enter the **field**, or even because of its own **activity**, as for example saturating its **environment** with its products or **waste**.
5. Finally these limiting factors overwhelm its drive and **growth** stops. The system is now well adapted and pass through a succession of up and downs due to temporary rekindling of its innovative capacity and, on the other side, bouts of sluggish routine or resistance in its **environment**.
6. The system's basic potential is finally spent and it loses **adaptability** to its **environment** and, even **control** over its own **elements** and **subsystems**, becoming thus exposed to a final destructive crisis.

3025

SERENDIPITY¹⁾

The faculty of making fortunate and unexpected discoveries by accident.

The term originates in the fairy tale "The three Princes of Serendip" (H. WALPOLE). It is now quite generally accepted in the forementioned meaning, since it covers a kind of very relevant mental activity. Indeed, in numerous instances quite important discoveries have been made in a seemingly sudden flash of illumination, which probably corresponds to a not yet clearly understood cerebral **process**, through unplanned and automatic neural **interconnections**. Of course, serendipity visits only well informed, open, inquiring and creative minds, who are able to *notice* the deep significance of some seemingly fortuitous **event**. (FLEMING discovery of penicillin, by *observing* a "spoiled" bacterial culture and inquiring for the cause of this unforeseen outcome). It is somehow akin to the "Eureka" syndrome and to the proper **perception** of unsuspected systemic **interrelations**.

→ **Clue, Effects (Side); Random phenomenon; Relevance**

3026

SERIALITY²⁾

The **relation** which is **transitive, asymmetrical** and **connected**. **Aseriality** is the absence of any of these **relations** (J. FIBLEMAN & J. FRIEND, 1969, p.33)

FEIBLEMAN and FRIEND give as an example of a serial **relation**: "the enclosure of apple seeds by flesh and of flesh by skin is a serial **relation**" On the contrary the **relations** between grains of sand "are aserial, since they lack **asymmetry**" (Ibid).

3027

SERVO-MECHANISM⁵⁾

A device that consists of a **sensor**, an **amplifier** and a **motor** and is used to maintain the steadiness of the mechanical device of which it is a **part**.

A servo-mechanism is in fact a 2nd level feedback applied in specific ways in accordance with the permanent nature and **function** of the regulated system

The servo-mechanisms are needed to regulate the regulating (or **control**) subsystem's **variables** in order to adapt them to the changing **environmental** conditions.

J. MILSUM writes: "... the **output** is required to follow or "track" slavishly an often-varying desired, reference or command **input**" (1968, p.43).

Examples are " ... power steering of cars,... or neuro-muscular systems used for positioning of limbs, eyes, etc." (Ibid, p.42).

The study of servo-mechanisms is interesting in relation to the **behavior** of **living systems**. According to G. SOMMERHOFF: "...since many servo-mechanisms produce some type of **goal-directed behavior** it is not surprising that some of the general concepts of servo theory can illuminate parallel forms of **goal-directed behavior in living systems** – concepts like **error control** and **feedback loops**, for instance. But there are many limits to this. The **goal** of the **activity** of a servo-mechanism is set by an **external** command. This **command** provides the reference **signal** from which the error **signals** are derived to which the **feedback** mechanism responds with the necessary corrections" (1969, p.153). Moreover, as noticed also by SOMMERHOFF, in biological (and social?) systems, the **commands** are integrated in a **hierarchy** of oriented **behaviors**. And still: "...the concept of **error signal** is also beset with difficulties... in such **goal-directed processes** as embryonic **growth**, maturation, **learning**, **evolution**, etc... – or even in such simple cases as a rat taking the correct turning at a **choice** point of a maze" (Ibid.).

3028

SET²⁾

A collection or **class** of perfectly differentiable **elements**, which is considered as a **whole**.

Sets are usually represented by letters, while their **relations** are represented by connecting **symbols**.

A set can be:

- **finite**, if it contains a finite number of **elements**;
- **infinite**, if it contains an infinite number of **elements**;
- **ordered**, if each **element** occupies a well defined place;
- **null**, if it does not contain any **element**

The set of all **elements** taken in account is the universal set, or **universe**.

Any set has a complement, i.e. the set which contains all the **elements** not belonging to the former one.

A **subset** is a set included within another one.

Sets may overlap, i.e. have at least one common **element**. On the contrary, sets without any common **elements** are disjoint sets.

Operations on sets are described by G. BOOLE's binary algebra. The well known **VENN diagrams** are geometric **representations** of sets. These **representations** have been recently generalized by A. EDWARDS (1989).

3029

SET THEORY in systemics^{1) – 2)}

Systems are more than sets. R. ROSEN observed that: "Most of the difficulties of "**General System Theory**" have arisen from a confusion between systemhood and set-ness; the at-

tempt to treat those properties of a particular system which depends on its systemhood as if it were simply a part of the Theory of Sets" (1991c, p.214).

This is related to the difference between cardinality and order relations.

→ **Logical types; Theory of types**

3030

SHANNON LIMIT⁵⁾

The theoretical limit for how much **information** a **communication channel** can carry.

Information is taken here in a strictly quantitative **meaning**.

It refers to the efficiency of a broadcast system in terms of the number of **bits** of information per second that it is possible to send, for ex. per herz in a radio bandwidth.

3031

SHIFTING (or SWITCHING) CAPACITY^{1) - 2)}

The possibility for a system to modify its internal links at least up to a certain point.

W.R. ASHBY states: "A system whose **variables** can be sometimes fluctuating and sometimes constant is adequately equipped for switching" (1960, p.167).

This implies that only some points of the interconnection **nets** is active at any moment as, again, stated by ASHBY: "Any system with a 'switching' **process** must use... an alterable **distribution** of constancies" (Ibid.).

This is specially important for systems whose **communication network** is of paramount importance, as for example a telephone system and, generally, **neural networks**, natural or artificial.

Parts of the **network** which are not linked become for some time independent, but altogether, inactive.

3032

SHOAL

→ **Boids; School; Squeezing effect**

3033

SIGMOID²⁾

"A function that has a low, shallow slope initially, followed by a steeper rise that gives way to another shallow slope" (M. CAUDILL, 1992, p.15)

The author comments: "Its value always increases as its **input** increases, yet at the same time it is bounded by minimum and maximum values" (Ibid.).

The sigmoid is characteristic of the **logistic** equation. It reflects a growing **dominance** of some **negative feedback** in the **process**.

3034

SIGN^{1) - 3)}

Any **event** registered by an **observer**.

Signs are necessarily **percepts**, visual, auditive, tactile, etc. They imply **abstraction** (PEIRCE's "abstractive **observation**"), **distinction**, **frames of reference**, **learning**, **memory**, **observation**, **representation**, etc...

There are numerous different viewpoint about signs, more or less complementary and compatible. The given definition is very general, but admittedly somewhat simplistic.

F. FRISCHNECHT and J.P.van GIGCH give a different definition: "Signs are **symbol tokens** or **symbol carriers**" (1989, p.241). The **tokens** or carriers are **events** and only **observers**, mostly humans, are able to understand them as **symbols**. The **observer** needs thus to possess a **repertory of significances** if he/she is to interpret the sign. If this condition is fulfilled, the sign becomes an **information element**. G. KLAUS writes: "As significance bearer, the sign possesses a **structure**" (1976, p.915). It is the **perception** of this **structure** that generates the **information**.

C.S. PEIRCE considered that the most perfect signs are those which carry about equal symbolic, iconic and indicative loads.

Following C.S. PEIRCE, F.Y. SEIF explains: "A **semiotic** sign is an indivisible **triadic structure**: sign (or what PEIRCE calls a "representamen"), **object**, and interpretant. Anything is a sign if it represents an **object** and determines an interpretant. The term "**object**", although empirical, is not necessarily a material thing" (1992, p.810). A good example could be the "cross" in the Christian religion.

SEIF reckons however that: "While this **structure** is inadequate for the **dynamics** of physical or metaphysical **phenomena**, it nevertheless represents an **image** of a **frozen** moment in the **semiotic process**" (Ibid.).

Any sign may affect the **behavior** of the **observer**, provide he/she is able to recognize it some significance, or even possibly its lack of significance (being disconcerted or scared by something registered, but not interpreted).

Ch. MORRIS (quoted by R.L. ACKOFF and F.E. EMERY) "... discusses three types of **signification** (**semantic** properties) of signs and three corresponding 'dispositions to react in a certain way' (pragmatic properties). **Semantically** speaking a sign, for MORRIS is:

1. *Designative*, "insofar as it signifies observable properties of the **environment** or the actor, (as black)"

2. *Prescriptive*, "insofar as it signifies how the **object** or **situation** is to be reacted to so as to satisfy the governing impulse, (as ought)"

3. *Appraisive*, "insofar as it signifies the conformatory properties of some **object** or **situation**, (as good)".

"The corresponding (pragmatic) **functions** are to produce:

1. "A disposition to react to the designated **object** as if it had certain observable properties"

2. "A disposition to act in a certain kind of way to the designated **object** or **situation**"

3. "A disposition to act toward a designated **object** as if it would be satisfying or unsatisfying" (1972, p.171).

Still another classification of signs is proposed by A. CORNELIS:

"**Natural sign**: An undifferentiated mixture of **meaning content** and **meaning carrier**. Natural signs are dominated by emotive **meanings**. Thus for example the **meaning** of the mother for the child illustrates a natural sign... (It is) the emotional layer build up with the help of natural signs (that) makes possible the construction of a basic **knowledge** system..."

"**Linguistic sign**... as it has been defined by de SAUSSURE. First de SAUSSURE stresses the **distinction** between **meaning content** and **meaning carrier**. Second de SAUSSURE defines the **relationship** between **content** and carrier as arbitrary..."

"**Abstract sign**: An abstract sign has the logical characteristic of abandoning any arbitrary or natural **relationship** between **meaning content** and **meaning carrier**. This **process of abstraction** is characteristic for scientific thought and more generally for... the scientization of **culture**. **Meaning contents** and **meaning carriers** are not longer organized by their interrelationship - either natural or conventional - instead they develop into two different systems, of **identity** on one side, and **structure** on the other side" (1986, p.141-2).

Shortly, a sign tends to produce (more) **information**, **learning** (or training) and motivation.

Signs may have a more or less embracing, i.e. systemic, implicit **significance**, that may be differently perceived by different **observers**. They may be more or less efficient from a **semantic** viewpoint, according to what **significance** the **receiver** is able to give them. As observed by U. ECO: "... the labor of sign production also represents a form of social criticism and of social practice, a sort of ghostly presence" (1979, p.314). All **cultures** have their own, slightly different ways, to construct signs and individual interpreters are largely subservient to this global **process**. See for instance MARUYAMA's **mindscapes**.

Signs can also be **ambiguous**, for example in poetry or painting, presenting a great number of possible connotations (M.C. ESCHER's engravings are a notorious example).

A very significant historical study and comparative critical evaluation of the notion of **sign**, made by N. LUHMANN was reproduced in the Journal "Cybernetics and Human Knowing" 6 (3) p. 21-27.

This work intended "to combine systems theory with sign theory by trying to integrate G. SPENCER BROWN's "**Laws of Form**" (N. ORT and P. MARKUS, 1999, p. 39-46)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3035

SIGN AND SYMBOL ³⁾

While a sign is simply something which *may* carry a **meaning** for some definite **observers** with the needed background, a symbol is a "something that represent something else by association, resemblance or convention..." (AMERICAN HERITAGE DICTIONARY, p.1302).

According to C.S. PEIRCE: "A sign is either an **icon**, an index or a **symbol**. An **icon** is a sign which would possess the character which renders it significant, even though its **object** has no existence; such as a lead-pencil streak representing a geometric line. An index is a sign which would, at once, lose the character which makes it a sign if its **object** were removed, but could not lose that character if there were no interpretant. Such for instance, is a piece of mould with a bullet-hole in it, as sign of a shot; for without the shot there would have been no hole; but there is a hole there, whether anybody has the sense to attribute it to a shot or not. A **symbol** is a sign which would lose the character which renders it as sign if there were no interpretant. Such is any utterance of speech which signifies what it does only by virtue of its being understood to have that **signification**" (in J. HOOPES, 1991, p.239-40).

D. Mac KAY gives other examples: "An overcast sky "means" that rain is imminent." (1969, p.88) This is just an observed **situation**, which need not necessarily and is not intended to exert a preselected influence on the **observer** and induce him to some specific **behavior**.

On the contrary, when **learning** the national anthem, anyone is supposed to adopt a dignified and at times quite precisely, specified attitude because the anthem is a symbol of the mother country to be respected and honored.

In short, signs nature, **perception** and use are an unavoidable bedrock for systemics. This explains the precursor role of linguists, semioticians and semanticists in systemics.

3036

SIGNAL ^{1) - 3)}

"A string or strings of **energy** and **matter** in transit between a **transmitter** and a **receiver**" (T.F.S. ALLEN & T.B. STARR, 1982, p.277).

According to ALLEN and STARR, "Its **meaning** is undefined" (Ibid).

This is so, at least, until we use a physical **code** (acoustic, electromagnetic, etc...) and/or a semantic one, shared by the sender and the **receiver**, thus endowing the signal with a **meaning**.

3037

SIGNAL (Binary) ²⁾

A signal emitted by a device that can produce only two significant **states**.

Binary signals serve to modelize binary relations, whose algebra was constructed by G. BOOLE in 1854 (1952).

The most obvious example is 0 and 1, both signals easily produced electronically, which correspond to any kind of dual oppositions: yes – no; positive – negative; false – true; existent – non existent; etc...

3038

SIGNAL (Iconic) ^{1) - 3)}

G. BATESON gives the following example of iconic signal: "The bared fang at a given instant may *mention* an attack which, if and when it occurs, will include a *new* baring of the fangs" (1973, p.393).

This supposes that the **receiver** is able to understand what he perceives with its correct **meaning** within a formerly learned **context**, i.e., any signal supposes common understanding of a shared **coded context**.

3039

SIGNALS (Discrete or continuous) ²⁾

G. PASK discusses the different characteristics of discrete or continuous signals.

He observes: "Discrete signals carry with them greater assurance, for the instrument (Note: i.e. the detector) only needs to decide which one of a few signals occurred" (1961a, p.125).

This is the reason for the generalized use of **digital codes** in place of **analogical** ones.

As stated by PASK: "Generally, the discrete signals leave less uncertainty about their source than continuous signals both for **organisms** and **machines**". Even so, "Various **coding** schemes, more or less efficient, more or less fallible can be used; for example, in a discrete system the intervals between individual pips may or may not be a signal and able to convey **information**" (Ibid).

As an example of continuous signal, PASK offers "...the concentration of a specific chemical hormone in the bloodstream" (Ibid).

Continuous signals seem best adapted for the **regulation** of systems oscillating within a **stability** zone limited by some **thresholds**, i.e. **homeostatic systems**.

3040

SIGNALS (Forerunner)

→ Forerunner signals

3041

SIGNIFICANCE/SIGNIFICATION

→ Meaning

3042

SIMILARITY ¹⁾

A likeness between systems **structures** and/or **processes**.

The concept of similarity is quite elusive. It is not merely an **analogy**, in a **metaphorical** sense, but the clear recognition of an **homomorphism**. Similarity is *observed*. This means, in A KOESTLER's words, that it "involves **processes** of **abstraction** and generalization in the nervous system which are largely unexplained" (1964, p.201).

To become more than an **analogy**, similarity must be described in **topological** (i.e. graphical) or mathematical terms. KOESTLER, for instance, speaks of "**bisociation** of conceptual **matrixes**", which implies a kind of **mapping**, or **pattern-matching**.

Recognizing similarities is a highly creative mental **process**, typically systemic. It produces at times amazing results, as for example when A. WEGENER introduced the idea of continental drift, conducive to plate tectonics, having observed geographical complementary similarities in the forms of continents.

The observation of some **dissimilarities**, on a background of similarities, can be just as productive, as shown by DARWIN's Galapagos finches.

"Similitude" is a synonym unfrequently used.

→ Self-similarity

3043

SIMPLEXITY ²⁾

"The **emergence** of large-scale simplicities as a direct consequence of **rules**" (J. COHEN & I. STEWART, 1994)

Simplicity can be considered as a near-synonym for S. KAUFFMAN's "**antichaos**".

M. SHERMER comments: "These predictable **laws** (of nature) interact with unpredictable **contingencies** to occasionally trigger the "**collapse** of **chaos**". After the **collapse** simple **rules** "emerge from underlying **disorder** and **complexity**" (1997, p.25)

The whole subject seems to be closely related with the disordering of systems of lesser **levels** by excessive **energy inputs**, the appearance of growing and unwieldy **fluctuations**, the crossing of a **critical point**, and the **emergence** of a more complex system around a new **nucleus**, as described in Prigoginian **thermodynamics of systems far from equilibrium**.

3044

SIMPLICITY ¹⁾

Character of a **process** or system which can be described through a quite limited number of **operations**.

H. SIMON shows how **apparent complexity** in our **models** results many times of our lack of **understanding** of the underlying simplicity of **relationships**. He gives as an example the simplification of the Ptolemaic cosmological **model** by COPERNIC, KEPLER and NEWTON (1990, p.129). This could however be a case of

"Seek simplicity, but distrust it". In effect more than two centuries later, POINCARÉ demonstrated that, while correct in principle and in general, classical cosmology could not explain some anomalies in planetary orbits, a result that led later on to the discovery of **chaos**.

→ "Self-similarity".

3045

SIMPLICITY (Organized) ¹⁾

The character of the deterministic motion of a single, or two interacting moving **elements**, or more generally of the interplay of two or three **variables** at most.

W. WEAVER (1948) coined three expressions to differentiate simplicity and complexity:

- Organized simplicity, simple, **deterministic**;
- Disorganized **complexity**, complex, **random**;
- Organized **complexity**, **self-organizing**, **ergodic**, **chaotic**.

Classical science, until the last decades of the 19th Century, based on **deterministic models**, discovered and explored organized simplicity, as for example in mechanics, optics or acoustics.

Disorganized **complexity** was then tackled by the newly introduced statistical **methods**, as for example in **thermodynamics**.

Organized **complexity** became under investigation only in the 20th Century and its study is still in full development.

3046

SIMPLICITY (Principle of maximum) ²⁾

"The **structure** of the **organism** is determined as the simplest possible physical **design** which can perform the necessary **function** with the required intensity" (N. RASHEVSKY, 1960, p.125).

It is originally a biophysical principle. It is however clear that it applies (or should apply!) to **organizations** in general, but specially to the most complex ones.

RASHEVSKY observes that the biophysicist D. COHN proposed the expression, more precise according to him, of "Principle of optimum **design**". Considering that the word "optimum" implies the necessity of establishing a **criterion** of such "optimality", the advantage is not evident.

3047

SIMPLIFICATION ¹⁾

As a **set of methodologies** to study "organized **complexity**" (W. WEAVER, 1953), systemics and cybernetics have introduced new **modes** of simplification.

Some interesting examples, among others, are:

- J.G. MILLER's general principles of **organization of living systems**

- H. SIMON's **hierarchies of subsystems and modes of decomposability of complex systems**
- G. KLIR's **Reconstructability Analysis**
- J. WARFIELD's **Interpretive Structural Modeling**
- H. HAKEN's **Synergetics**
- H. SABELLI's general **Process Theory**
- D. Mc NEIL's general **Toroid model**

In general these **methods** aim at identifying coherent complex units within more global **wholes**. As jokingly stated by J.L. LE MOIGNE, a system should not be sliced as a sausage.

G. KLIR defines a "*basic simplification principle*": "A sound simplification of a system should minimize the loss of relevant **information** with respect to the required reduction of its **complexity**". He adds: "Among all comparable simplifications of the given system, we accept only those with minimum **uncertainty**" (1991, p.401).

Even such complex **transformations** as the **ergodic** or **chaotic** ones, are made more intelligible by **models** whose systemic character is evermore widely recognized.

3048

SIMULATION ^{1) - 2)}

"The **representation** of a system to study its **component parts** and their **relationships** in terms of variable **inputs** and **outputs**".

Or "**Representation** of natural and **social systems** or **processes** by devices or **models** that imitate the **behavior** of the systems or **processes**" (UNESCO-UNE, 1983, p.14).

A.G. BARTO describe simulation as follows: "The **method** used to find the **model's** global **behavior** base of **knowledge** of an **initial condition** and the locally acting **constraints**" (1991, p.388).

As observed by F. FRISCHKNECHT and J.P. van GIGCH, simulation is basically the creation of an equivalence **relation** between **objects** and adequate **symbols** (1989, p.243). This is the deeper **meaning** of "**representation**". *Adequate symbols* must be at least **homomorphic**. As to "**objects**", they are normally complex, i.e. include internal **relationships** and, when useful, external **connections**.

Simulation **models** are necessarily dynamic.

"If... a computer is used to generate the **model's behavior**, we call the **process** computational simulation" (A.G. BARTO, Ibid). This author discusses simulation either by **continuous**, or **discrete models**. However, whatever the **method** used, the real value of simulation depends on a correct **understanding** (in relation to the **goals** of the **operator**) of the system to be modelled and the nature of the significant **data** to be obtained; of the satisfactory **homomorphism** between the conceptual **model** and those characteristics of the system to be mod-

elled and, finally of the adequate translation to the computer **model**. If these different conditions are not fulfilled, the well known motto "Garbage in, garbage out" defines the results.

The quality of the results depends, of course of the **fitness** of the **model**, i.e. of the validity of the criteria used for its construction, irrespective of the simulation **technique** applied. In M. SHUBIK's words: "... once the **model** has been formalized, the insights and errors of its builder will be reflected without question by the simulation" (1967, p. 151).

In any type of simulation, the user of the results to be obtained must remain interactive with the investigator in charge, in order to maintain the **relevance** of the simulation in relation to the concrete **situation**.

The main techniques in use are **analog** and **digital**. An important variant is **aleatory simulation** ("Monte Carlo" method), which introduces **constructed randomness** in the **model**.

Simulation is generally aimed at **prediction** of the **behavior** of the simulated **process** or system. For a number of practical and conceptual reasons, the results can however never be fully guaranteed.

Apart of **prediction** R. AXELROD also states the following uses of simulation (1997, p.16-17):

- Performing certain tasks using **artificial intelligence**, as for example "...medical diagnosis, speech recognition and **function optimization**..." and "... simulations of task **environments** can also help design new techniques"
- **Training**: "...Flight simulators for pilots is an important example of the use of simulation for training"
- Entertainment: as for example "... simulations of completely imaginary worlds"
- **Education**: "... The primary use of simulation in **education** is to allow users to learn **relationships** and principles for themselves"
- Proof: ... "CONWAY's **Game of Life** demonstrates that extremely complex **behavior** can result from very simple **rules**"
- Discovery: ... "Using simulation for prediction can help **validate** or improve the **model** upon which the simulation is based... and for the discovery of new **relationships** and principles..."

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SIMULATION (Analog) ²⁾

A simulation of a **concrete process** or **network** through a mechanical, hydraulic or electrical **model**, whose **behavior** is considered equivalent.

H.T. ODUM writes: "Analog simulation has many purposes. The **process** of setting up **flows** and functional **parts** is a powerful stimulant to the imagination, helping one to be precise, to ask new questions about the particular **networks**, and to secure the right **measure-**

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

ments. The electric **flows**, being very fast, can simulate much slower systems. Because electrons and their control pieces are very small, they can model large systems that would be expensive or impossible to manipulate experimentally" (1971, p.258).

ODUM gives the simulation of the **flows** of groundwater across the state of Nebraska as an example and states: "The flow of electrons in wires is so fast that fifty years of changes can be observed in a short **time**" (Ibid).

3050

SIMULATION MODELS (Taxonomy of) ^{1) - 2)}

H. PRAEHOFER resumes as follows T. ÖREN's taxonomy of models "... for which he uses the following classification criteria: **time set** of the model, **trajectory** of descriptive **variables**, existence and range of **variables**, functional relations of **variables**, spatial **distribution**, **organization** of **component models**, and **goals** to be pursued...

"According to the criteria **time**, we speak of **continuous-time** models when **time** is represented by real numbers and we speak of **discrete-time** models when **time** is represented by integers or a **set isomorphic** to the integers. According to the second criteria, we speak of **continuous change** models when **state changes** occur continuously over **time** and we speak of **discrete-change** models when they occur in **discrete** jumps. Pairwise combinations of one category for each criteria define well-known modeling concepts. **Continuous-time** and **continuous-change** models are differential equations specified models, **discrete-time** and **continuous-change** models are difference equation specified models, **discrete-time** and **discrete-change** models are **automaton** models, and **discrete-change** and **continuous-time** models represent the class of **discrete event** models".

Practically: "The real system is regarded to be nothing more than a source of **data**. The model is a **set** of instructions capable of generating such **data** and the computer is a means of carrying out these instructions to generate such **data**."

"A direct relation exists between the real system and the model and is summarized by the term **modeling**. A direct relation between the model and the computer exists and this relation can be denoted as **simulation**" (1991, p.287-289)

3051

SIMULATION (Modes of) ²⁾

The French systemist B. WALLISER distinguishes the following **modes** (1977, p.183-5):

Analogic: a simulation mode consisting in using a mechanical, hydraulic or electronic device whose functional **behavior** is equivalent to the system's one.

Digital: a mode using a numerical **model**, generally analytical, and which can be translated into a **computer program**.

Deterministic: a mode considering **variables** and **interactions** as perfectly determined, producing unique **output** values as a **function** of **inputs**.

Operative: a mode consisting in working on the real system, or some similar **concrete system** in "laboratory conditions".

Random: a mode introducing **randomness**, i.e. putting the **variables behavior** under the influence of a **random** procedure ("Monte Carlo" method for example).

The value of the results depends of course on the hypotheses used and the **model's** limitations.

3052

SIMULATION (Systemic) ^{1) - 2)}

Systemic simulation implies very difficult problems. It has to reproduce in a satisfactory way the **nonlinear** character of the **complex system** to be modelled (once well and clearly defined in relation to the modelizer aims) and their possible **chaotic behavior**.

There seems to be still much ground to cover in order to complete a good theory of such simulation.

H. PRAEHOFER states: "Through the **complexity** of real systems, a fully comprehensive **model** of a real system is infeasible to build." (1991, p.300, quoting B. ZEIGLER). He adds: "**Modeling** always means idealization, **abstraction**, and **simplification**. Only some aspects, the aspects of the real system relevant for the **objectives** in hand, may be incorporated into the **model**" (Ibid).

Until now the best systemic **modelization methodology** seems to be ZEIGLER's "Multifaceted **modeling methodology** whose central concept is the "**system entity structure**" (1994, p.169-178).

3053

SIMULTANEITY ¹⁾

F. HEYLIGHEN points out that in **relativistic** theories "the **relationship** of simultaneity becomes relative (i.e. dependent on the reference frame of the **observer**") (1990a, p. 438).

This can be generalized.

Due to variable **time lags**, in no type of **transmission process** is **transmission** instantaneous. Thus simultaneous **events** in different **parts** of a system remain unconnected for some **time**.

Event A and **event B** can influence each other only after a **delay** and only if and when some of their consequences meet and interact in some place. So, in any **complex system**, somewhat disconnected areas of **activity** do

always exist: simultaneous causes do not generally produce simultaneous **effects** in the system as a **whole**.

This is the basic cause of **nonlinearity** and **chaos**.

3054

SIMULTANEITY: the relativist view ^{1) - 3)}

F. HEYLIGHEN writes: "In **relativity** theory, we have the principle of **relativity** together with the principle of invariant speed limit **c** for **causal propagation**, which entail the impossibility to distinguish **simultaneous** from non-simultaneous **events** that are spatially separated" (1990a, p.441).

This is the case, for instance, of somebody observing the sky at night. The simultaneous character of the observed celestial show is a perceptive **artefact**.

HEYLIGHEN views this principle as an example expressing "the impossibility to establish a certain classical **distinction** in an absolute way" (Ibid).

R. FISCHER states, in a different sense: "... the **covariance** between the "external motions" of substance "out there", and "internal motions" (the **subject's** systemic rate of **change** as a reflection of his/her arousal) that results in **invariant** features of the **transform** (**interface** or reality) is a principle of *neurobiological relativity*" (1991, p.99).

3055

SIMULTANEOUS EFFECTS ^{1) - 3)}

Simultaneous **perception** by neurons is not absolute.

J.von NEUMANN writes: "...Wherever "simultaneity" is mentioned in the above (note: i.e. in nerve stimulation), it cannot and does not mean actual, exact simultaneity. In each case there is a finite period of grace, a **summation time**, such that two pulses arriving within such a **time period** still act as if they had been simultaneous. Actually, things may even be more complicated than this – the **summation time** may not be a sharp concept. Even after a slightly longer **time**, the previous pulse may still be summed to the subsequent one, to a gradually decreasing, partial extent" (1958, p.55-56).

Perfect simultaneity thus seems to be still one more abstract concept, which conceals a practical observational impossibility, even at the **receivers** end.

3056

SINGULARITY ^{1) - 2)}

"Specific locus where a radical **transformation** takes place, called **bifurcation** by mathematicians" (C. BRUTER, 1989, p.438).

A singularity is in most cases the result of a repetitive **positive** and non compensated **feedback** bringing about an accelerating **accumulation**; it is an exceptional **phenomenon**. The

function or system thus reaches a **runaway** "point of no return", or **threshold**, locus and moment of sudden **discontinuity**, or **catastrophe**, which may destroy the system or trigger a deep structural and functional **transformation**, corresponding to a **bifurcation**.

The singularity is necessarily the result of a dynamic **process**, leading to an "extremality".

Cl. BRUTER states that "... the most interesting and significant **phenomena** in our universe are those of genesis or end of things ("generatio" and "corruptio")" (Ibid).

He adds: "We must note, in case of a singularity, the increase of the potential capacity for **evolution**... In any common point, the direction and value of **growth** are fixed" (NOTE: in mathematical terms, the **function** representative of the **process** is **continuous** and derivable) "At the singularity point, we are in an expecting **situation**. Crossing this point, there will be **growth** or decrease" (Ibid., p.441).

BRUTER enumerates as follows the basic physical properties of singularities:

"By its **extremality's** properties, a singularity is **visible**.

"By its **uncommon** character, it is **valuable**: the spatio-temporal **costs** of its making is high

"By the specific geometry in its **vicinity**, it plays the role of an **organizing center** around itself, as well structurally as functionally, due to the fact that the local **transformation** potential is generally higher than at regular points" (Ibid).

Insects molting or a revolutionary **change** of political regime are examples of singularities.

→ "**Nucleation mechanism; Nucleation principle**".

3057

SINGULARITY (Bifurcation) ^{1) - 2)}

Cl BRUTER describes its two principal properties as follows:

"Bifurcation appear for values of the bifurcation **variables** forming void measures sets in the **variables space** of the bifurcation." (1989, p.449)

Bifurcation singularities are very unusual situations!

"For these singular values, mathematical objects show degenerated forms."

"All this corresponds to very understandable physical situations. If the **structure** of any **object** is to be modified, it must first pass through a dissolution phase of the initial **structure**, at least, partly".

"This phase is only transitory, in view that the **object** looses its immediate qualities of **stability**" (Ibid).

BRUTER cites the example of insects metamorphosis, in which "...the chrysalid's formation leads to the practical dissolution of all the organic systems... quickly followed by a assembling phase in which the organic systems of the adult insect are elaborated from special embryonic **cells**." (Following DENTON: 1988)

3058

SINK ¹⁾

A fixed point that acts as an **attractor** for all points in its **neighborhood**.

There is no escape from a sink.

2. A place in the **environment** of a system which receives **waste** from the system.

Different types of **waste** go to different types of sinks, which receive either material (rubbish dumps of many different types) or energetic **waste** (f. ex. the atmosphere, as receptor of heat, i.e. degraded **energy**).

As the use of materials and **energy** is growing exponentially, the problem of sinks is growing at the same pace. This introduces the need for reusing as much as possible all kind of **waste** as **sources** of useful **resources**, i.e. the need for **recycling**.

Recently, we also started to create **information** sinks, by accelerated **accumulation** of unused (or unusable) **data** and premature invalidation of techniques. This will probably become a very serious problem in a near future.

3059

SITUATION ¹⁾

"Some **state** of the world at a given instant, focused from the **viewpoint** of some definition of a system" (M. LIU.1990, p. 40).

According to LIU we look for "...a **representation** of the world from a selected **viewpoint** and in relation to a predefined study objective. We prefer the term "situation" to the one of "state", in view that this latter one tends to be restricted to the **description** of the inside of the system, while a "situation" describes the system, its **boundaries** and its **environment**" (Ibid).

Of course, neither the "state", nor the "situation" can ever completely be described.

What we call a situation is merely the imperfect result of a set of simultaneous or nearly simultaneous **perceptions**, associated in a manner as coherent as possible, and to which an **observer** is able to give a global **meaning**.

A situation relates generally to the instantaneous **state** of a complex **entity**. R. ESPEJO stresses that: "... the **complexity** of the situation is defined by the number of non-equivalent outcomes recognized by the **viewpoint** in the situation" (1988, p.140). The **viewpoint** may be individual or shared through constructed **consensus** among various **observers**. In any case: "Individuals only see 'sides of a situation', never the **whole** of it; indeed there is no **viewpoint** that can capture in full the **variety** of a situation... not least because human activities are constantly being created and recreated by the people participating in it" (Ibid, p.139).

Moreover, a situation is only a fleeting **event** in a chain of **events**.

The **observation** of successive situations allows to perceive a system or a **process** in course of **transformation**.

However, the **coherence** that may be perceived in the situation also depends on the previous **knowledge** by the **observer** of the **constraints** prevailing in the observed **universe**. This **knowledge** may be insufficient, for example because of the lack of historical **data**, or the inexistence of some means of **observation**, or due to some prejudices.

In these (very general) cases, the situation is partly "**invisible**" in G.de ZEEUW's sense (1992), and the **observer** may be led to a false **evaluation** and thus induced to commit mistakes. In St. BEER words: "He is playing a **game** of incomplete **information**" (1968, p.279).

According to R. ESPEJO: "...The **complexity** of the situation is defined by the number of non-equivalent outcomes recognized in the situation by the **viewpoint**" (1988, p.140). ... or by the different **viewpoints** of the participating **observers** during a period of **time**.

J. WARFIELD, inspired by G. VICKERS, recommends the use of the term "situation" in "replacement for the more commonly-used "**problem**", because: "It has been frequently observed that a **problem** is, invariably, a human **construct** not subject to **observation**. A situation, on the other hand, is at least partly observable, if not fully so. Inherently, it is dynamic, changing with **time**, and its **observation** is not limited to any one individual. On the contrary, because it is often distributed in **space** and **time**, **observation** by various **observers** is often essential to its **understanding**. Moreover this term keeps the door open to exploration, while **problems** often harden into too-narrowly-defined **frames of reference**" (1990, p.9).

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SITUATION COMPLEXITY INDEX ²⁾

J. WARFIELD proposes the following **criteria** to judge the **complexity** of a situation:

"Necessary and sufficient conditions that a situation be **complex** are that the situation maintains seven **components**: a) human presence, b) a generic **purpose** associated with human presence, c) exercise of **system inquiry** by the human presence, d) human purpose-related **infrastructure** to make possible the **system inquiry**, e) system-related **environment**, f) sensing apertures for **space-time** sampling of the situation by the human presence, and g) **cognition** on the part of the human presence" (1995, p.31).

This is a quantitative index, whose practical use is explained by WARFIELD (p.32).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3061

SITUATIONS (Large scale)^{1) - 4)}

"Situations that engulf large number of people and **artifacts** in hazardous **networks** of **interdependence**".

J. WARFIELD, who gives this definition, adds: "To allow such situations to be designed irresponsibly or to permit final **decisions** that unleash horror upon tens of thousands is not conducive to civilized existence" (1990, p.14).

While this is obvious for systemists, who possess **methods** and **models** for consensual **modelization** of large scale situations, and techniques for **design** to be eventually applied, unfortunately such techniques are still ignored by most of the generally self-appointed managers.

3062

SIZE (Critical)^{1) - 4)}

The limit of a system's size, either inferior, or superior, which impedes its **survival**.

Any system, individual or social, has size **limits**: a minimum one below which it cannot organize itself and a maximum one beyond which it is not anymore able to sustain itself.

These size **limits** are defined by various interconnected conditions, namely:

SIZE (Minimum accretion)

Systems need a minimum number of coordinated **elements** in order to acquire sufficient **variety** by their possible **interactions**.

M. BUNGE calls this the "**threshold size**" "below which the **aggregate** does not form a system" (1979, p. 37).

Only when a critical mass is obtained does the system-forming **process** become able to dominate centrifugal forces or to polarize the uncoordinated **behavior** of free **elements**. For example, according to D. GORDON: "The size of the (ant) **colony** determines the number of **interactions** between individual ants, which results in a **change** in the **dynamics** of the **colony**" (1995, p.55).

A satisfactory surface-volume relationship: This necessity has been explained in a quite exhaustive manner by d'ARCY WENTWORTH THOMPSON in his great classic "On Growth and Form" (1916-1952, p.22-27) (*in the chapter "On Magnitude"*).

From a systemic **viewpoint**, each **form of organization** implies a specific **interrelation** between **invironment** and **environment**. As the **environment** grows, the **inputs** of the system must grow proportionally and this increasingly taxes the **environment**, as well as the more or less permeable **boundary**. As for similar shapes the surface increases as the square when the volume does it as the cube, there is a definite **limit** beyond which the **interfaces** between the system and its **environment** is not anymore able to provide the system with sufficient **inputs**.

Density: A minimum density is needed for the system to be coherent, lest **communication** becomes too difficult and costly, or even downright impossible. However, when density turns excessive, **communication** becomes blocked by the sheer **crowding effects** in **space** and **time**.

M. RIDLEY emits the hypothese that, for human beings, there is a "natural group size" of about 150 individuals.

This is roughly "... the number of people in a typical hunter-gatherers band, ... in a typical religious commune, ... in the average address book, ... in an army company.....

It is, in short, the number of people we each know well" (1996, p.69).

Once over this natural size, the **organization** of the group could show a lessened **fitness**. This could lead to the necessity to integrate various **groups** into a wider supergroup, i.e. lead to **emergent hierarchy**.

It would be interesting to research this **model** as a general systemic condition in other types of **groups**, as for instance, **networks of neurons** in the **brain**, or **networks** of participants in an Internet site.

Communication rate: The **coherence** of a system depends on a **communication** between **elements** and **subsystems** at a **rhythm** sufficient to maintain their **interactions**.

The **communication time** is directly proportional to the media's velocity and inversely proportional to distances. The first factor, may compensate the second one: Modern telecommunications are quickly "shrinking" the world.

Regulation and control cost: As a system grows and differentiates, the **interrelations** between its **elements** and **subsystems** must be growingly monitored and regulated in order to avoid internequine **conflict**. Moreover, **complex systems** tend to need and built **hierarchies** and pyramidal **controls**, which absorb a growing part of the available **resources**.

When the cost of **regulation** and **control** becomes overtaxing, the system finds itself exposed to self-destruction by **sclerosis**.

Moreover, an old or aging system loses much of its **adaptability** which causes **communication** and **control** problems. As a result, while its size remains unchanged, it may become unmanageable.

M. BUNGE relates the maximum possible size with a number of **components** "above which the system breaks down" (1979, p.37).

Ian I. MITROFF and Harold A. LINSTONE explain: "... all **processes** have an upper **limit** to their **efficiency**. At some point bigness boomerangs on itself. Instead of leading to greater end benefits, it produces negative end **effects**. These negative benefits are almost impossible to foresee and go completely counter to the hypothesized benefits of bigness" (1993, p.13).

Limits to size is thus a general functional and structural **rule**.

3063

SIZE (Optimum)^{1) - 2) - 4)}

The functional efficiency of a system is related to its size, which in turn depends in some measure from the nature of its **environment**. Marine mammals, for example may be bigger than terrestrial ones, as they benefit from water buoyancy.

In a similar way, the optimal size of a **group** or society (insect or human) is a **function** of its **communication means**. This may explain why some past empires declined and fell: overextended **communication lines** (as related to **communication means**) and consequent **time lags** in needed reactions may have been a cause of disruption.

It also explains why archaic **groups**, as for example equatorial forests dwellers, living off quite limited natural **resources** exploited with very simple tools, cannot reach a high **population level**.

3064

SLAVING PRINCIPLE^{1) - 2) - 4)}

The **control** of many **variables** in a system by an **order parameter**.

This principle, basic in **synergetics**, has been introduced by H. HAKEN (1983). It involves an important mathematical formalism which cannot satisfactorily be reproduced here.

This "enslavement" (such a disagreeable language!) results of the final synthesis of multiple **constraints** between **elements** in confinement when the number of **elements** increases and/or the available **space** is progressively reduced.

The slaving principle reflects somehow the transit from statistical **randomness** toward global ordering. (H. HAKEN & A. WUNDERLIN, 1990).

→ System (Composite)

Accordingly, HAKEN states that the **order parameter** is shaped by the **interactions** between individual **elements**. Once it "coagulates" in the form of a higher **level regulator**, it takes the **control** of the system as a **whole**. This is a very general **phenomenon**: for instance in laser light, in clouds rolls, in social amoebas, in fashion fads and in political **ideologies**.

For some interesting structuring examples, see "**Belousov-Zhabotinskii reaction**"; "**Bénard's instability**"; "**Dictyostelium discoideum**"; "**Hexagonal space filling**"; "**Soliton**"; "**Stigmergy**"; "**Swarm**".

The slaving principle could be very significant for sociology.

3065

SLOVENIAN SOCIETY OF SYSTEMS STUDIES¹⁾

This Society includes mainly scholars interested in so-called "General Systems" from Slovenia, but also Austria, Croatia and Germany.

Its center is at the University of Maribor and it has been impulsed since many years by Matjaz MULEJ, his colleagues and collaborators.

It has also close connections with scholars in India and the USA.

The most recent work of the group: "System Thinking and Climate Change System (against a big "Tragedy of Commons" of all of us", 2002) is an outstanding demonstration of the practical value of **systems thinking** as applied to vast and complex issues.

→ **Mitwelt; "Nothing but " fallacy; Responsibility in Systemic terms**

3066

SLOW-DOWN^{1) - 2)}

The characteristic lengthening of **adaptation time** in physical systems near **saturation** or in **ageing living systems** or **organizations**.

Slow-down seems to be provoked by the existence of a **limit** to the number of possible adaptive combinations of **elements** or **characters**.

It is reflected for example in **growth curves** of **logistic** type, representing the progressively reduced **rate** of expansion of some technological innovation, or of the renewed diversification of a severely disturbed **ecosystem**. It corresponds to a **negative feedback**, generally related to some **environmental** factor, which produces a braking effect.

3067

SMALL WORLD²⁾

"A network containing many **nodes** that have a few **links**, together with a few nodes- or **hubs**-with many links"(A. FROOD, p. 33)

FROOD connects this **model** with the **power law distribution**: "This arrangement...greatly reduces the number of steps needed to link any two **nodes**, compared with a completely regular **network**"(Ibid)

According to A. LASZLO BARABASI (Univ. of Notre Dame, Indiana) "The very **topology** of these **networks** plays a crucial role in how these systems behave". And "finding that food **webs** follow a **power law distribution**, just like we see for the **cell**, and the internet, suggests that nature displays a high degree of economy when it spans its various **networks**-it uses the same blueprint for most of them"(Ibid)

3068

SMALL WORLD EFFECT²⁾⁴⁾

A property of a **network interconnection** grid in which some apparently unrelated and widely separated **elements** turn out to be directly connected.

This is a general characteristic of many **networks**, whose importance has been emphasized by D. WATTS in a recent book (1999).

It appears when a few (even very few) **elements** have long-range **connections**, which put in contact some widely separated ones.

This is an intermediary **state** between **networks** wherein **elements** are only connected to their close neighbours and those wherein some **elements** are globally connected in a **random** way. Some few long-range **connections** in a **network** allow for the swift and efficient long-distance **propagation** of initially local **effects**. A limited number of this type of **connections** introduces specific **constraints** in the **network**. This should not be the case if too many long-range **connections** would be introduced in a completely **random** way. (R. MATTHEWS, 1998, p.7)

The presence of **constraints** in "small worlds" **networks** introduces a kind of **fuzzy** global **communication** ordering, even if the network lacks an organizational center.(R. MATTHEWS, 1999, p.27). This could be for example the case of the general **brain organization**, or the world's scientific research **community**. In both cases, a reduced number of specific long-distance **links** is enough to create a global **coherence** when each of the linked **elements** has its own regional or specific **network** of connections whereby or wherefrom it can relay any **information**.

Small world models could be very useful for the study of the present **globalization** trends in ecology, economy, **communication networks**, business, politics, social organization, cultural evolution, etc.

The small world **model** can be useful in widely different **situations**, as for ex. in epidemiology, in **brain** studies, in electronic circuits, in **communication** and **energy** distribution networks (... and their failures!), in fads and fashion **propagation phenomena**, etc...

→ **Hypercube architecture**

3069

SMOOTHING²⁾

A technique to eliminate supposedly **random** variations in **data flows**.

K.De GREENE states: "The smoothing or averaging of **information flows** in **system dynamics** can be thought as an attempt to achieve perfect **information**. There is no 1:1 **relationship** between a smoothed **information variable** and the true physical **variable** it rep-

resents. As in the real world and in all realistic **models**, **information** in **systems dynamics** is subject to bias, amplification, attenuation, **noise**, and **delay**" (1994, p.3-21).

Quoting FORRESTER (1961, p.407), he adds: "Smoothing is a **process** of taking a series of **past information** and attempting to form an estimate of the **present** of the underlying significant content of the **data**". De GREENE comments: "Smoothing is done to attenuate rapid **fluctuations** and thereby to reduce **meaningless noise**... Smoothing eliminates **random events**... it appears that a great deal of **real information** is lost by averaging and smoothing. The very capability of the system to evolve may be lost" (p.15) (for more on this, see "**Systems dynamics**").

Of course, these effects result of at least two features in **modelization**:

- 1) What is deemed *meaningless* by the modelizer;
- 2) Classical **models** of **complexity** do not take **deterministic chaos** in account and may even eliminate **data** which could reveal it.

3070

SNOWBALL EFFECT¹⁾

A colloquial way to express **percolation** effects at **critical instability thresholds**.

Snowball effects correspond to **avalanches**, panics, epidemic propagation and generally **runaway processes**.

3071

SOCIAL CYBERNETICS²⁾⁴⁾

Under these terms the Brazilian sociologist V.De GREGORY, University of Sao Paulo, proposed a cybernetic view of **human social systems**.

According to him, any society includes three typical **groups** in **interaction**:

- the "official group", a small minority that controls the social levels and generally manages society as a **whole**
- the "opposition group", also a small minority that promotes a deeply different view of what social **organization** should be
- the "silent majority" that gathers most of the people, observes a more or less passive attitude and obeys the **rules** defined by the "official group", at least as long as the general **situation** remains acceptable for them

In case of serious or deep trouble, the "silent majority" may switch their adhesion from the "official group" to the "opposition group". Socio-political disorder thus activates a **feedback** that changes the **equilibrium** of the society.

In fact, this theory would possibly be based on the **catastrophe model** of R. THOM.

→ **Backside balance; Criticality; Social pathologies; Stress; Trigger effect**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3072

SOCIAL ENTROPY⁴⁾

"A **measure** of the natural **decay** of the **structure** or of the disappearance of **distinctions** within the **social system**" (K. KRIPPENDORFF, 1986, p.70).

This **concept** is used by various authors. It must be however observed that it is mainly **metaphoric**. While **phenomena** of **decay** and **destruction** are evident and frequent in **social systems**, they have really never been "measured". The **concept** should be refined and given a more precise content.

It is, notwithstanding, true that **social systems** ultimately subsist on **energy inputs** and produce **entropy**, as can be seen by their production of **waste** and the frequent degradation of their **environment**.

In more recent years, K.D. BAILEY (1990, and subsequent papers) expanded the scope of the social entropy concept, stating that "we clearly need a macrosociological **systems theory** that is broad enough to incorporate nonliving **elements** such as **technology**, along with living **elements** such as social **organization**" (1998, p. 6).

BAILEY proposes his social entropy theory (SET), including "six important and interrelated factors that are used by every society- large or small- in its everyday **development**", namely **Population, Information, Space, Technology, Organization** and **Level of living** (for which he stamped a vigorous acronym: PISTOL). Moreover, or one should say, to begin with, "each society utilizes **energy**...to adapt to its particular spatial **environment**".

"This involves doing work through both its available technology, and its particular level of organization". (Ibid)

As to **entropy**, according to Bailey, if the society is successful it can be controlled at acceptable levels, this allowing the society to maintain or even increase its level of living" (Ibid)

This corresponds obviously to PRIGOGINE's **theorem of minimum entropy production** and **dissipative structuration** in **systems far from equilibrium**.

In Bailey's model if the society is "unsuccessful for any reason (e.g. overpopulation, inadequate energy resources, faulty information processing, antiquated technology or bureaucratic **pathology**) then entropy may increase, perhaps to the point where the very future of the entire society is in doubt" (Ibid)

This apparently corresponds to a violation of the minimum entropy production theorem: the society squanders uselessly a considerable part of its energy's **inputs**.

On the other hand, Bailey's views are quite critical of T. PARSONS' ones, as this author

based his social **models** on the concept of **equilibrium**, in a form that "precluded or blocked the effective analysis of social **change** in systems not characterized by equilibrium" (1996, p. 8)

3073

SOCIAL ORDER THEORIES¹⁾²⁾

Most social order theories of the 20th century are highly critical of all kind of social orders, past or present. However, viewed from a systemic angle, they seem generally weak in their deeper **understanding** of social order in general and of its basic nature.

The **Frankfurt School** theories, for example, including HABERMAS one, has marxists roots. Of course, MARX social order theory was a very original approach, as well as a socially very "engaged" one. Marx **description** was in some sense implicitly systemic, offering an **explanation** of the **structures** and **functions** that made the 19th Century capitalist society coherent and self-reproductive. But this was lost in the massive **noise** of subsequent ideological controversies and totalitarian power abuse.

In fact, social **coordination, coherence** and **dynamic stability** can be obtained only through specific devices securing organized and non-contradictory **relationships** among **elements, subsystems** and the global **entity** they constitute. A good general description of social **organization** at any **level of complexity** was given by J.G. MILLER in his **taxonomy of living systems**.

In particular, many distinct **regulations** are necessary to harmonize elements into subsystems (i.e. individuals into **groups**) and subsystems into the globally organized social entity.

Moreover, as regulations tend to order themselves into a pyramidal scaffolding at distinct levels, they are easily accaparated by the **regulators** themselves (just mere individuals exerting a specific function). In this way, regulations become **controls** and the **controllers** frequently turn self-perpetuating and reproducing, as well as oppressive.

Oppression is in fact the confiscation by controllers of means in excess of those needed to maintain **coherence** and **dynamic stability**. This devious **process** is nothing new in history as they existed in practically all past human organizations, specially political ones (Roman, Chinese, Inca, Aztec and in the Moslem World, as described by ibn KHALDOUN). In modern democracies, power becomes frequently appropriated by self-appointed "elites" or by a corrupt political establishment.

The final problem- in systemic terms- is resumed by the famous saying: "Who will control the controllers?". It derives in trying to find out some better way to obtain and maintain social coherence. A possible solution (in theory) would be universal personal **understanding** of the fundamental conditions of social order, its ac-

ceptance and the practice of universal personal **responsability**. But can this antidote to oppression and **anarchy** become a practical proposal?

→ **Action theory; Emancipatory systems approach; Herd effects; Parasitism; Right and responsibilities (Bill of); Social entropy; Social systems; Theory and Design; Sociality; Society order parameters; Sociobiology; Stigmergy; Swarm intelligence**

3074

SOCIAL PATHOLOGIES⁴⁾

Numerous social pathologies can be usefully explored through systemic inquiry. Some examples are:

- the build-up of abusive inequalities and their stabilization through legal and political structuration;
- pathology of transculturation;
- the mechanisms and consequences of bureaucratization;
- the problems resulting from excessive **size**;
- the return to archaic political and cultural forms after the destruction of centralized or imperial **structures**.

3075

SOCIAL REFLEXIVITY⁴⁾

J. CUNNINGHAM (2001, p. 65), quotes A. GIDDENS (1990) and writes: "Anthony GIDDENS has argued that the society in which we live is increasingly the result of our own **actions**, both individually and collectively, a condition he refers to as social reflexivity. He counters the common assumption that as we acquire more and more **knowledge** of the world and build **structures** of society, we will gain **control** over our lives. Quite the contrary, we "manufacture" **uncertainties** that give us more **choices**, diverse possibilities, less clarity about an appropriate **action**. Modern technologies such as the World Wide Web have contributed greatly to social reflexivity and I argue that traditional **models of education**, emphasizing as they do inductive and deductive **processes**, are inadequate to the modern technological **context**.

"...I propose that **abductive** reasoning is a more powerful mode for navigating the **uncertainties** of the Information Age and promoting a **semiotic reflexivity**" (Ibid)

In short, **conversation** should become our best way to discover ways to permanent **adaptiveness**. Of course conversation must be conducted through efficient reciprocal understanding if we are to avoid the universal Babel Tower effect. This implies the necessity of an appropriate- and also reflexive- **language**

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SOCIAL REPRESENTATION

→ **Representation (complex)**

3077

SOCIAL SCIENCES METHODOLOGY: A CRITIQUE^{2/4)}

M. MARUYAMA criticizes in the following terms some methods used in contemporary social sciences:

"During the 2nd half of the 20th Century, social sciences and psychology have taken a course which, while attaining considerable results, built a skewed orientation in their theories and methodologies:

"1. The classificational **logic** which became dominant separated rather than related various aspects of our ways to organize **knowledge**, aesthetic preferences, **concepts** of what is respectable and moral, composition, **choice** of scientific theories, etc...

"2. **Disciplinary** and subdisciplinary inbreeding not only confined the researchers in fragmented **niches** of knowledge, but also amplified the peculiarity of the theories and methodologies of each niche;

"3. The **ideology** of controlled **variables** nurtured the **habit** of ignoring the wider **context**;

"4. Formalized and standardized methods of **analysis**, made easier by **computer programs**, fostered blind faith in and reliance on the "magic box" computer to the extent that many of the researchers lost their habit to use their **brain** to think, analyse or interpret the data directly or raise questions regarding the nature and applicability of specific **computer programs** they use;

"5. **Data** collection became formalized and standardized, and many of the researchers lost direct touch with raw **experience**, to the extent of not trusting one's own **observation** and accepting only the **measurements** filtered through instruments;

"6. General theorists who rose as a **reaction** against specialization tended to have an aversion to specifics, and to look for superficial **analogies** and far-fetched **similarities** with a priori **assumption** of universality and propensity to wishful homogeneization;

"7. Some general theorists used ad hoc mathematical **models** which were either too simplistic or artificially complicated;

"8. Remedial attempts of **interdisciplinary programs** ended up either with a haphazard collage or a bazaar shopping for hunting and gathering of those ideas, filtered to take home which fitted what was inbred in the home niche. The interbreeding failed".

MARUYAMA, who has a wide experience of living in a number of different **cultures**, (just as this editor) proposes some remedies:

"A solution is **outbreeding**. One has to go out from the ingroup niche, get the feet wet and hands dirty with raw and contextual **experience**. Observational ability for details and **contexts** must be regained. Relations which escape standardized data collection and instrument **measurements** must be recaptured by

using one's senses and **brain**. One must also step in several other **niches**, learn their theories and methodologies, and create new ones on *their ground*".

In his paper, the Japanese author gives "examples of the current state of what he calls

"the art of relationality, outbreeding and contextual experiencing"(1998, p. 91-108)

3078

SOCIAL SOFTWARE

→ **Ethics (Normative)**

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SOCIAL SUBSYSTEMS^{2/4)}

As stated by O. THYSSEN (1995, p. 17): "Modern societies (as distinguished from traditional) are divided into functional subsystems such as economics, science, politics and intimacy".

These distinctions are LUHMANN's, who also added religion and law.

THYSSEN adds: "Each subsystem is closed and creates its own **domain** allowing only certain **operations**. As a consequence, it is not possible to observe- or handle- society as a **whole**, as no vantage point exists from which to do so. As a further consequence it is not possible to talk about what is rational for society as a **whole**, or what will benefit society as a whole".

And "A functional subsystem has limited possibilities of observing and cannot observe "the world as it is". Economics cannot observe "real needs" and politics cannot observe "real voters". What they can observe are **diagrams** showing changes in sales or in voter support" (Ibid)

This kind of global social agnosticism should possibly be relativized. There are clearly positive or negative **symptoms** of the state of a society as a whole. It sometimes loses **coherence** as a whole, particularly when the distinct subsystems enter in **conflict** and do not anymore negotiate stabilizing balances between their possibly conflictive needs, **aims** or **beliefs**. This is a result of disfunction of the social **regulators** and **controls** and, or inoperancy of A. SMITH "invisible hand"

This incipient trouble can readily be observed, through a spreading uneasiness and increasing civil protest or rebellion.

3080

SOCIAL SYSTEM⁴⁾

1. "An adaptive and **complex system** composed of causally related **components**" (B. BANATHY, 1973, p. 88).

2. "A **concrete system** composed of animals that a) share an **environment** and b) act upon other members of the system, either directly or indirectly, in ways that are cooperative in at least one respect" (M. BUNGE, 1993, p.212).

Sociosystem seems to be a perfect synonym for social system. M. BUNGE states: "Every society is a sociosystem but the converse is not true: industrial plants, schools, and clubs are sociosystems but not societies. A society is a self-reliant sociosystem".

Accordingly: "A sociosystem is a society if and only if it is self-sufficient, i.e. does not depend entirely upon other sociosystems" (1979, p.177).

According to BUNGE: "The systemic view of society should not be mistaken for the *organismic* view, a variant of **holism** according to which sociosystems are **organisms**. Surely, the **components** of sociosystems are alive; besides, sociosystems are born, develop, and become extinct. However, they are not alive: if they were, then all of the peculiar laws of the living, and in the first place those of genetics, would hold for them. But these do not, hence sociosystems are not alive. Nor are they dead: the categories of life and death do not apply to sociosystems" (1979, p.241).

The organismic view is merely a not very satisfactory **metaphor**.

However B. BANATHY and M. BUNGE's definitions show that the **concept** of social system may considerably exceed the **limits** of human systems. In some sense, any **complex system** is a social system and one of the most important tasks still awaiting **systemics** is the construction of an integrated theory of **sociality** or **associativity**, as it could be called.

Such social systems are any kind of integrated **networks** of **components**, with specific **constraints** commanding their functionality.

The concept of social system was born independently from **General Systems**. As a result, some misunderstandings pervade its sociological use. They appear neatly in J.W. LAPIERRE who (according to M.N. SARGET) "... differentiates five social systems: the bio-social system, the ecological system, the economic system, the cultural system and the political system" (SARGET, 1993, p.373; LAPIERRE, 1974).

Any social system is necessarily "bio-", i.e. made of **living systems** (unless we consider atoms or molecules as social systems...). Such bio-social systems are inevitably inserted within an **ecosystem**, of which they are a **subsystem**. As to the economic, the cultural and the political systems, they are really **subsystems** of any (**human**) **social system**, forming a complex interacting network (of networks). LAPIERRE's ideas are basically sound and even systemic, but his vocabulary could induce serious confusions.

LUHMANN views social systems as systems of **communication**, which creates their own unity, **structures** and **elements**.

This very general concept obviously applies to:

- social phases in **congeries** of normally non-connected individuals. An example is **Dicystelium discoideum** and another, less constraining is a locusts **swarm**
 - social insects among which communication has a biochemical origin (**pheromones**) and is absolutely basic for the communal **activity** (**stigmergy**)
 - human groups and societies, wherein **languages** of various types are the basis for communication
 - social **automata**, for which **parallel distributed processing** seems to herald future complex societies of **automata**
- **Autopoiesis: about Luhmann's view**

3081

SOCIAL SYSTEM (Growth of a)⁴⁾

The growth of social systems tend to be **logistic** and to flatten out after reaching some **level** that corresponds to the general type of the system.

D.M. GORDON for instance observed that an harvester-ant **colony** stops growing in **size** after about five years. She moreover showed that: "The **size** of the colony determines the number of **interactions** between individual ants, which results in a **change** in the **dynamics** of the **colony**", until its **organization** stabilizes "about the same time it stops growing in **size**" (1995, p.55).

It thus seems that optimum internal **organization** corresponds to some optimum **size**. This could also be interpreted in terms of optimal **communication**: neither insufficient because of a low number of participants, nor **overloaded** by their excessive **density**.

3082

SOCIAL SYSTEM (Human)⁴⁾

"A social system composed of human beings and their **artifacts**" (M. BUNGE, 1993, p.212).

M. BUNGE distinguishes among human social systems:

"1. **Natural or spontaneous** if and only if it is self-organized (i.e. if it emerges spontaneously by **reproduction**, accretion or self-assembly)". BUNGE's examples are: "Families, street-corner gangs, and bands of hominids".

"2. **Artificial or formal**, or an **organization** if and only if it is other-organized, i.e. set up and maintained according to explicit plans and **rules**". BUNGE's examples: "Schools, churches, business firms, and government departments are artificial systems" (Ibid).

E. JANTSCH and C. WADDINGTON considered however that: "The evolutionary **paradigm** is still almost totally neglected by a social science which finds its purpose in reducing the human world to the **equilibrium** perfection, structural unambiguity and permanence, **hierarchical control**, and **predictability** of **machine-like structures**" (1976, p.2).

G. VICKERS also insists on the dynamical nature of the human social system and describe it as: "... a **set** of ongoing **relations** between persons and **organizations**, governed by mutual expectations which are usually embodied in **roles**. It is of course a very complex **pattern**. Each of us forms part of several **subsystems** and each of these is incorporated in varying degrees in others...

"... we distinguish something that we regard as a continuing **entity** but only to the extent and in the **field** in which it maintains, through **time** two **sets** of **relationships** which are themselves intimately linked – the internal ones which relates its members to each other and the external one which links it, as a **whole**, to its surround. The entity is in fact a **pattern** of **relationships**, subject to **change**, but recognisably extend in **time**" (1967, p.59).

Such a description seems to fit however *any* social system, be it a trade-union, a beehive or even possibly, up to a point an **ecosystem** or a **brain**.

In a closely related sense, T.R. YOUNG and G. SWARTZMAN observe that "... all social systems depend upon **information flow** in order to survive as **thermodynamical entities**" (1974, p.259).

Organizationally closed **values subsystems** are the most important **sources** of such **information flows** in **socio-cultural** or **socio-historic systems**. **Information flows** also seem to exist in insect societies, albeit in different forms.

In the restricted sense of human systems, R.L. ACKOFF and F.E. EMERY propose the following definition: "A system whose **elements** are **purposeful** individuals" (1972, p.215).

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SOCIAL SYSTEM THEORY AND DESIGN¹⁾²⁾⁴⁾

Early in the development of **systems thinking**, very important proposals were enounced by C. West CHURCHMAN (1968, 1971, 1979) mainly related to the design of social systems. Churchman, a pioneer in **operational research**, became early disillusioned by its limited scope. He quickly veered toward a much wider **approach**. He recognized that many different worldviews are possible. As a result he tried to "develop a **holistic, interdisciplinary**, experimental science addressed to problems in social systems" (M. JACKSON, p. 222, 2000) Consequently "...it becomes clear that **subjectivity** should be embraced by the systems approach. Systems designers must accept that completely different **evaluations** of social systems, their **purposes**, and their **performance** can and do exist. The only way we can get near to a view of the whole system is to look at it from as many perspectives as possible" (Ibid, p. 222)

Churchman himself states (inspired by the pragmatist philosopher E.A. SINGER): "...the Singerian inquirer pushes **teleology** to the ultimate, by a theory of increasing or developing purpose in human society: man becomes more and more deeply involved in seeking **goals**" (p. 254, 1971)

He remains however cautious. In JACKSON's words: "For Churchman, systems and whether they work or not are in the mind of the **observer** rather than in the real world. A **model** can only capture one possible **perception** of the nature of a system. **Objectivity**, therefore, can only rest upon open debate among holders of many different perspectives.

And the results of a systems study can only receive their guarantee from the maximum participation of different **stakeholders**, holding various worldviews, in the **design process**" (p. 224, 2000)

These views have been echoed in distinct ways by various systemists. Bela BANATHY Sr. used it as a springboard toward a **methodology** of design oriented to idealistic projected **goals** (Fuschl and Asilomar Conversations).

However, even a **consensus** among various **observers** obtained through conversations does not guarantee that all important aspects have been considered and integrated. **Under-conceptualization**, as described by J. WARFIELD (or FOURASTIÉ's ignorance of ignorance) remains always possible.

In such cases, idealistic design can be led widely astray and produce less than happy results. No good design can be obtained merely through generous intentions.

This is why R.A. BRYER, for example, taxed Churchman's work as "idealistic and impractical". Of course "realist and practical" ways are frequently used as cover-ups for opportunistic and even dishonest design.

JACKSON expressed this as follows: "(Churchman) assumes that genuine participation in dialectical debate can be arranged and that there is a possibility of achieving synthesis. To those who see the social world as characterized by **asymmetry** of power, structural **conflict**, and contradiction, these are pious hopes indeed" (Ibid, p. 226)

Anyhow, Churchman's views represent a lively current in the systemist movement and his methodological proposals have exerted a far-reaching influence on many systemic thinkers. A good example is the development of the **concept** of **Evolutive learning community**, elaborated mainly by Alexander LASZLO during the 1998 Fuschl Conversations.

→ **Design conversations; Design (Co-participative); Design culture; Design (Generic); Design inquiry; Design (Systems); Generic design science; Group Technique (Nominal)**

3084

SOCIAL SYSTEMS DESIGN METHODOLOGY^{1) - 2) - 4)}

An open discussion procedure for the **design** of adaptive **social systems** in **communities**.

This methodology derives from **co-participative design**, as introduced by the **Fuschl Group**.

SSDM has been proposed by G. DYER, who describes four stages in such **processes** (1995, p.8):

1. "Introduction: This stage envisages an Initiator who believes that a **social system** redesign is necessary and who then approaches another member of the **community** with a Draft **Declaration of Interdependence** as a way forward".

The Initiator should clarify the terms **independence**, **dependence** and **interdependence** as a conceptual foundation for SSDM.

2. "Development: This stage assumes that with two people now committed to the **design process** further cascading takes place. Further amendments to the Declaration take place and at some stages, meetings are called to clarify points that have been raised".

"The Declaration must be presented as a continuously evolving ideal – members of the **group** must be reassured that they have the right to suggest amendments to both the **domains** and details within **domains**, or indeed to suggest entirely new **domains**".

3. "Incorporation: This stage includes the possibility of a Draft Bill of **Rights and Responsibilities**, being developed by dialogue to incorporate the **community's** agreements"

This includes "freedom of expression" and "freedom to act". "Responsibility" includes "recognise that **actions** will be seen to be inappropriate if they place others in a position of vulnerability".

4. "Review: "... individuals will be reflecting on their experience of being a member of the **design** team in the absence of any prior formal education in **systems design**, their experience becomes their education" (Ibid).

This type of design through group dynamics should be compared with WARFIELD's **Nominal Group Technique**. It seems to lack a technique to avoid **underconceptualization**, but it has strong positive psychological effects.

3085

SOCIAL SYSTEMS MODELING^{2) - 4)}

According to P.M. ALLEN, "we find three basic issues that must be addressed in modeling social systems:

"A social system is firmly embedded in an **environment** with which it exchanges **matter** and **energy**, and it also has an internal **complexity**. Both these realities can, at certain moments, modify the average **behavior** of the system.

"The **evolution** of such a system is an interplay between the average **behavior** and rationality of its actors, and the **fluctuations**, **deviations** and **perturbations** around this average caused by the **environment** and by individuals within the system. Such an **evolution** involves both **determinism** and **chance**. The former is associated with the **variables** contained in the reduced **description**, and the latter with **perturbations** that probe the **stability** of the system continually, but which are not contained in the reduced **description**.

"The **evolution** is described by a branching **tree** of possibilities in a **space** of increasing **dimensions** representing the qualities which are associated with the system. The branches are merely self-consistent or stable expressions of the **organization** and **interactions** of the **elements**. The **structure** becomes unstable and changes when it cannot cope with either internal or external **fluctuations**. (1982, p.35-37).

3086

SOCIAL SYSTEMS PARADIGM⁴⁾

K.C. BAUSCH describes a social systems paradigm which, in his opinion, emerges from convergent agreement among systemic thinkers (1998, p. 11)

He writes: "This paradigm unites insights about **dissipation** and **autopoiesis**:

"1. Social realities are **dissipative structures**

a. they are totally temporized

b. they are ongoing **patterns** that are maintained by their manner of continual **reproduction**

c. in **far-from-equilibrium** conditions, these realities are open to **bifurcations**

d. in far-from-equilibrium conditions, small influences can generate profound **evolutionary effects**.

e. an optimal **strategy** to create profound **change** is to concentrate energy at likely **bifurcation** points

2. **Social structures** are autopoietic

f. as ongoing patterns of **meaning** that are constantly being reproduced, **Social** systems structure their reality on the basis of expectations in order to cope with the complexities of their existence

g. the formula for sustainable and creative existence is to multiply contradictory expectations and to hold them as alternatives for futures **uncertainties**" (Ibid)

As observed by Bausch, these characteristics are closely related to technology, whatever the level attained by less or more evolved social systems.

→ **Autopoiesis; Energy; Entropy (Social); Santiago theory; Systems (Co-operative)**

3087

SOCIAL TIME

→ **Time binding; Time domain; Time frame**

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SOCIALITY^{1) - 4)}

The condition of a large **group** of **elements** which interact permanently in a coherent way.

Sociality seems to be somehow implicit in nature. Inherently, **elements** tend to interact, producing some order See "Order parameter"; "Power laws" and "Slaving principle". F. David PEAT writes, commenting on the slime mold (*Dictyostelium discoideum*): "The slime mold... shows how collectivity and individuality, **holistic** and **reductionist** aspects can exist within the same system. What is particularly interesting about the slime mold is the way how collective or **holistic behavior** is enfolded within the individual, and likewise, individual **behavior** is unfolded across the **whole**. The individual and the global **elements** are both contained one within the other – an approach that clearly requires a new mathematical approach to nature" (1987, p.67).

This aspect is manifest, for instance, in H.von FOERSTER magnets experiment, demonstrating "order from noise".

The maintenance of sociality implies **stability** through **organizational closure**. This seems generally true in all kinds of **social systems**, including archaic **human systems**. The accelerating **transformations** of contemporary human societies confront us however with a riddle in this sense, as closure of specific cultures is now challenged.

Sociality is still an insufficiently researched concept. Many aspects of it remain imprecise:

- which conditions predispose **elements** to **association** and why;
- which types of **elements**, specially **heterogeneous** ones display a tendency to associate;
- how do the **interrelations** become established and how are they **regulated** or **controlled**;
- why do some **elements** associate in a lax way, while others tend to form **complex** and **integrated systems**;
- how and why can a **composite system** (i.e., with lax **associations**) become an integrated one.

The aim of such a research would not be "socializing" all sciences, but find general **isomorphic models** for this quite universal **behavior**.

Sociality is even possibly related to the physical coordinating **process** at work in the formation of **solitons**.

Up to now, the most comprehensive view of sociality as a **phenomenon** closely related to **evolution**, in very general terms, from physics to biology, has been written by Carsten BRESCH (1977).

Other significant contributors were W. SCHWEMMLER (1989 and 1991) and J.T. BONNER (1993), mainly from a biological viewpoint.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

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SOCIALITY (Two types of)¹⁾²⁾⁴⁾

Sociality can be obtained through **interactions** either among very numerous individuals in a closely knit collective **organization** (an anthill, a beehive) or a small **group** of highly brained long living individuals (whales, elephants).

In both cases, the basic character is the **transmission of information**, massively distributed in the first case, or concentrated in specific bearers in the second one.

Human societies obtain probably their exceptionally high power of **organization** to the fact that individuals are at the same time very numerous, highly brained and long living. (see: WEIGART et al., p.278-87)

3090

SOCIALIZATION^{1) - 4)}

The **process of integration** of numerous interacting individuals into an emerging organized **whole**.

Socialization appears as a very general tendency in **living systems** at every **level of complexity**, from cells to insect societies and **human systems**.

It supposes a specific ordering of the **interrelations** among **components** and a long permanence in **time** of the global **organization** thus obtained (**time binding**). This implies in turn the need for its **self-reproduction** and a permanent **process of learning**.

The socialization **process** implies deep modifications of the society's **components**, which must enter in specific and differentiated **interactions**. In this way, some individual characteristics are considerably reduced, while the **interactions** introduce specific **links** by *orienting the elements behavior*.

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SOCIEDAD ESPAÑOLA DE SISTEMAS GENERALES (SESGE)¹⁾

The Spanish Society for General Systems was founded in 1982 by a group of Spanish scholars under the leadership of R. RODRIGUEZ DELGADO (its late honorary President), in Madrid.

After publishing for a time a Newsletter, it created the "Revista Internacional de Sistemas" in 1989, which publishes papers in English, French and Spanish related to theoretical and applied **systemics** and **cybernetics**.

It also contributed to the organization of so-called **Fuschl Conversations** in Spain (Alicante; Valencia).

Under the impulse of members of the SESGE, an Association of Systems was also created in Valencia and, in the same city's University, a Faculty of Systems was created in 1992. It is however mainly oriented to **Operation Research** and **Systems Dynamics**.

Another member of SESGE, J. ARACIL, of Sevilla University, is the main Spanish specialist in **Systems Dynamics**.

After the death of its founder, the seat of the SESGE has been transferred to the València University, where interesting applied systems studies are continued, mainly under the leadership of Antonio CASELLES.

The president of the SESGE is now Lorenzo FERRER, at the same University.

In Madrid the sociologist Francisco PARRA-LUNA (Universidad Complutense) applies systemic **concepts** and **models** to his discipline.

3092

SOCIETAL ORDER PARAMETERS^{2) - 4)}

K.De GREENE proposes this specific use of the concept of **order parameter** to living and specially to human systems. He explains: "When applied to complex **living systems**, order parameter describes the evolutionary waxing and waning of the system. The order parameter is a macroscopic collective **field**, **emergent at critical points** out of myriad **interactions** at the **microlevel**. The order parameter expresses stochastic generation of the new (structural **change**) and **deterministic** maintainance of the now established (structural constancy). The **emergence** of the order parameter represents a great loss of **degrees of freedom** at the **microlevel**; **microlevel behavior** now becomes **slaved** to the order parameter. Human **languages**, the great theistic religions, political belief systems, economic belief systems, and scientific/societal belief systems like the Newtonian **paradigm** are example of order parameters" (1994, p.12).

De GREENE offers a very interesting table of characteristics of Societal Order Parameter in human societies comprising ways of **values** creation and transformations, social **learning**, social **bifurcations**, and **long-wave cycle structure** (p.13).

The German systemist N. LUHMANN offers a similar view of the **dominance** of the social system, whose intrinsic global logic overwhelms the individuals. As resumed by M.C. JACKSON: "Humanity is dragged in the wake of the system. Individual hopes and aspirations simply respond to the system's **needs**, and **consensus** is engineered to improve the system's functioning. Even internal dissension, strikes and **conflict** represent the system readjusting to increase its **viability** and **effectiveness**" (1992, p.33).

The progressive destruction-absorption of small archaic societies by and within great **cultures** seems to be another similar **phenomenon**, in this case also favoring global **efficiency** and internal **differentiation** to the detriment of lesser social units. Inefficient gigantism does however lurk.

Societal order parameters can also be observed in animal societies, specially but not exclusively in social insects.

3093

SOCIETY for GENERAL SYSTEMS RESEARCH¹⁾

The original scientific body dedicated to systems research.

The Society, states K. BOULDING, "originated in a conversation around the lunch table at the Center for Advanced Study in the Behavioral Sciences in Palo Alto, California, in the fall of 1954" (1972, p.79). It was officially founded in December 1954, under the leadership of the Palo Alto initiators: L.von BERTALANFFY, a biologist; K. BOULDING, an economist; R. GERARD, a physiologist, and A. RAPOPORT, a bio-physicist. It was named at that time the "Society for the Advancement of General Systems Theory". The name was changed for the first time in 1957. It published from 1956 till 1984 a Yearbook containing a selection of the best papers on systems and **cybernetics** and still organizes a yearly meeting in different places in the world. Its membership is completely international and it has National Divisions and Regional Chapters, as well as Special Interest Groups.

The four basic aims of the Society were defined as follows:

- To investigate the **isomorphy** of concepts, **laws**, and **models** in various fields, and to help in useful transfers from one field to another.
- To encourage development of adequate theoretical **models** in fields that lack them
- To minimize duplication of theoretical effort
- To promote the unity of science.

According to a survey organized by G. KLIR in 1978, W. ROSS ASHBY (1903 - 1972) was by far the most influential person in systems movement. KLIR states "The great impact of ASHBY's work on systems movement can be explained, at least partially by the superior clarity of his writings, his unusual capability to recognize important principles where other see only trivialities, his great gift for essence preserving **simplification**, his broad interests, encompassing both cybernetics and general systems research, and his meticulous scholarship" (1991, p.36).

Since 1988 the name of the Society is "**International Society for Systems Science**". (see the corresponding entry for other details)

3094

SOCIOBIOLOGY¹⁾²⁾⁴⁾

"The systematic study of the biological basis of all social **behavior**" (E.O. WILSON, 1975, p.4)

Sociobiology is concerned with the **behavioral interactions** among members of the same species.

It has been a controversial subject since its appearance.

This seems to have resulted in part of its uses for explaining human behavior without much reference to the **complexity** of human **brain** and mind, which obviously vexed some sensibilities.

However, while men and mankind are an extreme case of a socially organized species, precisely because of the impact of higher mental faculties, the **emergence** of **socialization** in man is a result of **synergistic effects**, which are present since the lesser **levels** of life (P. CORNING, 1998b) and even possibly at the chemical and physical levels (C. BRESCH, 1977).

3095

SOCIOCULTURAL SYSTEM ⁴⁾

E. LASZLO proposed the following classification of sociocultural systems with their basic characteristics (in order of growing **complexity**):

- **Kinship system:** Kinship **organization** (Family, clan, tribe); multi-purpose stone tools; human **energy**; nomadic hunting territories; hunting economy; pictograms
- **Village system:** Special purpose tools; animal **energy**; farming economy; ideograms.
- **Empire system:** Theocracy-autocracy; metal tools; inorganic **energy**; integrated economy; writing; special purpose towns; administration.
- **Nation-state system:** Democracy; machine technology; transformation of **energy**; mechanical transmission of **information**; Newtonian science. (Federal or unitary state)
- **Planetary system:** Three dimensional **boundaries**; ecumenism; internationalism; **automation**; nuclear **energy**; electronic transmission of **information**; Einsteinian science (1974, p.40).

The socio-cultural system is basically generated as a **dissipative structure**, whose **complexity** grows (in human **brains**, in economic **structures**) in proportion of permanently available **energy**.

3096

SOCIOGENESIS ^{2) - 4)}

The process of **self-organization** and **emergence** of societies.

Such a **process** takes place through growing **interactions** between **elements** hitherto independent. Through general **evolution**, sociogenesis seems to have been a **process** of recurrent **emergence** by association at successive and growing **levels of complexity** of **elements** and groups of **elements**: complex molecules, cells, **organisms**, societies of **organisms**.

According to B. CORBARA and A. DROGOU, in insect societies "...the genesis of collective **patterns** and complex collective **decisions** may result from quite simple individual mechanisms, based on reciprocally competing **positive feedbacks**" (1993, p.835).

These authors developed a **model** ("COLONY") of sociogenesis in an anthill according to which:

- Each individual is dominated by a global and permanent **behavioral algorithm** giving it at any time the possibility to opt for one of three basic individual states needed in the anthill: caring for the brood; foraging or being inactive;
- The activity of each ant is a **function** of the demand for each specific task;
- The **level** of demand for each task is a result of the global **activity** at each moment.

This should be compared with P.P. GRASSÉ's concept of **stigmergy**.

C. DELAYE and B. CORBARA describe as follows the mechanisms of sociogenesis: "The transition from **autonomous elements** to integrated ones may result from two basic mechanisms: the first, that allows separated **elements** to gather while conserving their own **closure**, is **aggregation**; the second, which introduces a **dissymmetry** among the participating **elements**, is incorporation" (1993, p.843).

This viewpoint converges with V. CSANYI's view about the **autogenesis** of systems as a result of the reciprocal effects of basic **interrelations rules**.

Until quite recently, sociogenesis has been a spontaneous and automatic **process**.

It is quite more general than the shaping of human **groups**. In some sense, even organized **groups of cells**, or neurons seem to be self-generated societies. Colonial vegetals, animal groups and even biotopes can be somehow considered as societies.

Many systemic and cybernetic **models** have some validity for the study of sociogenesis: Social **groups** are **regulated** (or even **controlled**, in the case of human societies), they are generally **hierarchical**, they offer specific **modes of growth** (**stigmergy** and **dissipative structuration** for example), their **behavior** does not allow total **predictability** and is even possibly **chaotic**, etc...

All these **models** offer new proposals to sociology.

As stated by E. JANTSCH, sociogenesis "is increasingly becoming a matter of human **design** too, and bring **culture** into play" (1976, p.54).

This is surely a reason to try to use systemic and cybernetic **models**, but altogether a reason to be very careful in order to avoid unfounded **analogies**.

Another interesting comment by JANTSCH is that, in human societies, sociogenesis becomes "... the result of overlapping functional conscious, and superconscious **modes of learning**" (ibid., p.56).

Remains to be seen if we can become conscious of... superconscious **learning**.

3097

SOCIOGNOSIS ¹⁾³⁾⁴⁾

The understanding of a society by itself.

This definition is in some sense highly unsatisfactory, because it endows a collective **abstraction**- "society"- with a capacity for self **awareness** and **knowledge**. Let us in this case use the word simply as short-hand and in brackets.

Only individual historians and sociologists are able to offer their **interpretation** of their own (or other) "society" as it was at some time in the past and as it is supposed to be presently. Their opinions are- or not- known and accepted by a majority of the members of the considered "society".

In any case, what a "society" believes of itself and of other "societies" is of absolutely fundamental importance as a prime mover of its **behavior**. In many cases, it can even make it stupid or criminal. Such aspects were described and criticized more than one century ago by G.LE BON (1895) and S. SIGHELE (1892)

A reasonably credible sociognosis should be constructed (always in a provisional way) by a wide consensus among historians and sociologists. The study of societies as complex **congeries**, or peculiar types of systems, could be a useful **methodology**.

→ **Autognosis; Social emergence; Social field; Social system; Sociogenesis; Socio-historic system; Sociolysis; Socio-technical system**

3098

SOCIO-HISTORIC SYSTEM ⁴⁾

Any organized (i.e. structured and functional) human **group** whose duration supersedes the individual life of its members.

The socio-historic system is largely **autopoietic**: it remains constantly able to replenish its membership and to maintain its internal **organization**.

This **model** applies to tribes, countries, nations, enterprises, political parties, clubs, civic **organizations**, etc... J.G. MILLER's **descriptions** of **groups**, **organizations** and societies are very helpful to understand **structures** and **functions** in the socio-historic system.

The following quotes may apply to socio-historical systems. A. RAPOPORT and W.J. HORVATH wrote: "Quasi-biological **functions** are demonstrable in **organizations**. They maintain themselves: they sometimes reproduce or metastasize: they respond to **stresses**; they

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

age and they die. **Organizations** have discernible anatomies and those at least which transform material **inputs** (like industries) have physiologies" (quoted by L.von BERTALANFFY from 1959, in 1962, p.18).

In the same quite more than analogic sense, G. VICKERS wrote: "Institutions grow, repair themselves, reproduce themselves, decay, dissolve" (1957, p.4).

Another important aspect of socio-historic systems is their evolutive succession and the progressive **emergence** of more complex ones. This could be considered the basic frame of the whole of human history.

3099

SOCIOLOGY (Systemic)²⁽³⁾⁴⁾

M. BUNGE proposes a systemic sociology whose central thesis would be that "any structured **human group**, from a family to the **world system**, should be conceived as a system, made from human beings, and possibly their **artifacts**"

Moreover, in any human society, "it is possible to distinguish four closely interrelated **sub-systems**. These are the biological system, characterized by kinship **relations**; the economic system centered in work and trade; the political system characterized by administration and power relations; and the cultural system, united by... creation and **communication of information**" (1995, p.29-30)

3100

SOCIOLYSIS^{1) - 4)}

The **disaggregation** of a **social system**.

This **process**, opposite to **sociogenesis**, implies the disappearance of **interrelations** among constitutive **elements**, each of which, if able to survive individually, becomes independent and **autonomous**.

Sociolysis however generally entails the destruction of most of the severed **elements**.

Biological death is in some sense a sociolysis **phenomenon**. This is also the case of the destruction of an archaic society or an enterprise.

3101

SOCIOSPHERE⁴⁾

"The total sphere of human activity" (K. BOULDING, 1968, p. 114).

In this article on "Business and economic systems", K. BOULDING considers from an economist's viewpoint the various **subsystems** within the global human system, each with its own particular disequilibrating **feedback processes**.

It would seem however that the sociosphere depends basically of the **resources** of the **ecosphere** and that its internal disequilibria may, in not a few cases turn into a global abuse of

the **ecosphere**, because the global **interrelation** between both is believed to be a **positive-sum game** favoring the sociosphere in a unilateral way.

Considering this, no research on the sociosphere can be complete and secure if not connected with the study of the **interrelations** between sociosphere and its **ecosphere environment**.

3102

SOCIOTECHNICAL MACROSYSTEM⁴⁾

"An evolving society (which) has social, economic, technological, psychological, political, and other dimensions, and... interacts with the natural **environment**" (Adapted from K.DE GREENE, 1991, p.69).

The notion apparently includes regions, nations and possibly the world system in the making. It will always however be difficult to define the **limits** of such a system and to describe it in a more or less satisfactory way.

→ See also Technical macrosystem

3103

SOCIOTECHNICAL SYSTEM⁴⁾

"A combination of **interacting** people and technology" (J. WARFIELD – pers. comm.).

WARFIELD adds that: "The way in which systems success is interpreted requires that the people and technology be both separately and interactively successful in order for the system to be successful".

The problem lays evidently in the **criteria** selected to define and measure "success" (Technical?, economical?, social? ecological ?, or whatever). Different people may obviously select different **criteria**, possibly incompatible in their consequences.

WARFIELD gives the following examples: "Banking systems, computer systems, **communication** systems, educational systems, environmental systems, governmental systems, private enterprises, public enterprises" (Ibid).

The following observation by N. WIENER should obviously be pondered, even if it has some luddites undertones: "...the automatic **machine**...is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. It is perfectly clear that this will produce an unemployment situation in comparison with which the present recession (i.e. 1950) and even the depression of the thirties will seem a pleasant joke" (1950, p. 162)

While fifty years later, this dire prediction still never came true, it is also true that creeping unemployment tends to become more structural and not any more merely cyclical.

This mechanism should be closely scrutinized in terms of social **self regulation** and possibly the prudent introduction of some better "checks and balances" than merely unemployment allowances.

3104

SOCIOTOMY⁵⁾

The experimental suppression of some category of specialists in a society of insects.

These experiments have been practiced in ants and in bees colonies. (C.D. MICHENER, 1974). They lead to a regression of some furtherly specialized workers to a former state, together with a physiological rejuvenation of the affected insects. This is seemingly understandable only as a result of a social **regulation** affecting the anthill or the beehive as a **whole**, and based on complex physiological reactions of the whole **community**.

3105

SOFT PROBLEM

→ Problem (Soft)

3106

SOFT SYSTEMS DYNAMICS METHODOLOGY (SSDM)²⁽³⁾⁵⁾

The combination of two well known systemic approaches for the analysis of complex **problem situations**, namely P.B. CHECKLAND's **Soft Systems Methodology** and J. FORRESTER's **Systems Dynamics**.

SSDM has been introduced by R. RODRIGUEZ ULLOA, President of the **Instituto Andino de Sistemas** (Lima, Peru), who states that "It was felt that **Systems Dynamics** did not answer very clearly (the following) vital questions:

- Under which world-view are the **causal loops** constructed which show the (specific) **phenomena** occurring in the real-world?
- Who are the **observers** and why do they observe the real-world the way they do?
- Do human affairs and natural phenomena existing in the real-world behave under a "logical" and "rational" way i.e.: Is it possible to delineate a logical **framework** of how real-world phenomena behave?, or on the contrary, is it not possible because they behave in an "irrational" and unsuspected way?

(Note: "**rationality**" can be only in the eye of the beholder. The "rationality" of the armament industry for instance is not the same as the "rationality" of sustainable **development**, or of environmental care)

- If there is an "irrationality" in the **behavior** of the real-world's phenomena, which is the "rationality" that supports it?
- Is it possible then to model that "irrationality" under a **schema** which is based on a cause-effect rationality?

- Which are the reasons under which an **observer** choses a particular way of seeing a specific **problem-situation**? Which kind of interests and **values** push them to observe the real-world in that way?
- How can someone give a "**solution**" about something, if the "problem" has not been clearly understood or if the **consciousness** of the world-view under which it is being observed is neglected (or ignored)?
- Is the "solution" provided by the **Systems Dynamics** approach culturally feasible and systemically desirable?
- What learning points can be obtained from constructing **Systems Dynamics models** and implement them in the real-world?" (R. RODRIGUEZ-ULLOA, 1999)

It is to be noted that **Systems Dynamics** proposes answers to "What if"s hypotheses, applied to a pre-established **model** of the problem-world, sometimes constructed on very shaky observational and epistemological ground, but nevertheless uncritically used (FORRESTER's warnings notwithstanding!).

Accordingly, and to complement these question marks, the author establishes an ontological, epistemological and philosophical comparison **matrix** between **Soft System Methodology**, **Systems dynamics** and the emerging Soft Systems Dynamics Methodology. This latter includes and compatibilizes all the important features of SSM and SD.

→ **Catwoe; Clanthink; Design; Groupthink; Underconceptualization**

An overview of the Soft Systems Dynamics Methodology

RODRIGUEZ ULLOA describes the stages to be followed in applying the SSDM

- **Stage 1: Description** of the problem **situation** in its un-structured form.
- **Stage 2:** Creation of a "rich picture" of the **situation** by incorporation of important aspects frequently neglected as related to "problem-owners, clients, **actors**, their worldview, level and kind of power, their **relationships**, etc." (Ibid)
- **Stage 3:** Introduction of "problem-oriented **root definitions**", which can be used "in order to describe epistemologically ..." "irrationalities". Under this perspective "**root definitions** are used to express problematic **transformation processes**, instead of expressing **transformation processes** oriented to provide "solutions" to the problematic **situation**..."
- **Stage 4:** Building **dynamic models** of the "problematic **situation**". At this stage "a problematic **context diagram** of the **situation** is built up". Of course, this **context diagram** responds to the particular **Weltanschauung** (i.e. worldview) that the **observer** has emphasized in a particular problematic

root definition. Changes in the **root definition** originate changes in problematic **context diagram** and viceversa"

- **Stage 5:** Comparison of the **systems dynamics models** against the rich picture built at stage 2. This is a **process of validation** of the **models**, tending to verify if "the **model** expresses adequately what is happening in the real - world"
- **Stage 6:** Determinate feasible and desirable **changes**. This means mainly "culturally feasible" and "systemically desirable" (i.e., excluding any self-contradictory specific or global **action** or effect).
- **Stage 7:** Building dynamic **models** of the "Solving Situation". This step is needed because no satisfactory evaluation of the **models** is to be obtained without future projections of the possible consequences of their application.
- **Stage 8:** Express the **transformation process** needed to perform "improvements" of the problematic **situation**. If "some difficulties appear at this stage, due to systemically undesirable factors, then some **adjustments** are needed between stages 2 and 7, until a "good" **adjustment** is found"
- **Stage 9:** Implant feasible and desirable **changes** in the real-world This should not be done before reaching a satisfactory validation of the **models**.
- **Stage 10:** Collect all **learning** points and save them for future study and reflection. "The **learning** points come from the **sensitivity** analysis of **modelling** the "problematic **situation**" as well as the "solving **situation**" and the proper implementation **action** in the real-world (Stage 9)

A graphical **representation** of SSDM (given by the author) is very helpful for a better understanding, in particular because the **feedbacks** among the different stages are fully graphicated.

RODRIGUEZ ULLOA's paper provides a quite complete glossary of the terms used in SSDM

→ **Catwoe; Design (Generic); Soft Systems Methodology; Systems Dynamics.**

3107

SOFT SYSTEMS METHODOLOGY ⁴⁾

A methodology to be used "in ill-structured or **messy problem contexts** where there is no clear view on what constitutes the **problem**, or what **action** should be taken to overcome the difficulties being experienced" (R.L. FLOOD and M.C. JACKSON, 1991, p.168).

This methodology was created by P. CHECKLAND (1981), inspired by C.W. CHURCHMAN's work.

J.van GIGCH had previously defined soft-systems as "Systems that may adopt several states due to environmental conditions, yet preserve their original identities in spite of these influences" (1978, p.591). He added: "Usually

these systems are found in social sciences **domain**", i.e. the **domain** where different **stakeholders** may have different views on a given **situation**, of its possible future development, and about what should be done, if anything.

I. TSIVACOU synthesizes as follows the nature of Soft Systems Methodology: "SSM is a whole composed by conceptual **models** or action plans, i.e. by graphical **representations** and **meanings** which fill these **representations**. Thus SSM is a unity of two things, inseparably connected: **models** and **meanings**. The **models**, as the formalization of a thought **process**, are cultural products with their proper **structure**. **Meanings** are expressed by social **agents** and constitute the content of the methodology" (1993, p.274).

P. LEDINGTON emphasizes: "First, SSM does not assume that the **problem** is one of rational choice... SSM assumes that the designation of the **problem situation**, the definition of the **problem**, and the possible **goals** to be achieved are all problematic **elements** in themselves (1992, p.47)..."

"SSM can be seen as an organised approach to helping develop and maintain a good **understanding** of a **situation**. Thus a basic **process for inquiry** (or **methodology**) emerges:

"First, investigate the **situation** and gain an intuitive **understanding** of it.

"Second, grasp some basic names for ideas that are felt **relevant** to the **understanding**.

"Third, formalise the ideas into **models**, using some rules of formalisation.

"Fourth, compare the **models** with the features of the **situation** and assess the areas of match and mis-match.

"Fifth, evaluate attitudes toward the **situation** in terms of **problems** and courses of **action** based upon the revised **understanding** that has emerged from the formal **process of inquiry**.

"These five steps provide an organised approach to inquiring about the **situation**. The **cycle of inquiry** may itself lead to further **inquiry-oriented action** such as the collection of more detailed **data** about the **situation**, the revision of the **model** (or **models**) used in the **inquiry**, or to the modification of **action** in light of the new **understanding**" (p.51).

LEDINGTON adds: "The basis of SSM is an exploration of the relationship between ethos and actuality. In the first stage of SSM a basic **understanding** of the **situation** and the agenda of **problems** which actors recognise is assembled. The second stage is an attempt to recognise and formalise systems **representations** thought potentially to be **relevant** to the **situation**. The concept of the human **activity system** is then employed to give **coherence** to the formalisation **process**. Thus **relevant** systems are identified and conceptual **models** are created. In the sense discussed above these conceptual **models** are grounded in the ethos

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

of the **community** rather than in the actuality of the **situation**. The conceptual **models** are then compared with the actuality. In this way SSM provides tools and techniques for exploring the relationship between ethos and actuality in an organised and open manner" (p.55).

In other words, SSM is very far to be a culturally neutral **methodology**, not by itself, but rather through the subjacent cultural **frame** of its clients and users. This **frame** should not remain shrouded in **invisibility**.

Interesting comparisons could be made with J. WARFIELD's "**Interpretive Structural Modelling**" and "**Interactive Management**".

3108

SOFT TECHNOLOGY ¹⁾²⁾⁵⁾

"The scaffolding"(support systems, **group process** techniques, **design methodologies**, **decision making** processes) for individual and collective self-determination: know-why"; "know what for"and "care why"(K. BAUSCH, Glossary, Pers. comm., 2002)

"Soft"comes in opposition to "Hard", related to **methods**, techniques and **tools** used in physical sciences and, up to a point, in biological sciences. It means that the study of all human **behaviors** is more difficult and allows for a lesser degree of certainty than experimental sciences because of the impossibility to reproduce tightly controlled sequences of **events** and the great difficulty to obtain a secure **knowledge** of historical events and experiences. As a result, the **situation** at the "starting block" is never very well known, nor objectively evaluable.

Soft technologies are still quite "in the making"and in need of a better understanding in systemic terms, specially in their psychological and cultural dimensions.

→ **Design (generic); Design (Systemic approach to); Interpretive structural modelling; Underconceptualization**

3109

SOFTWARE ^{2) - 5)}

Programs redacted in **symbolic languages** adapted for the **operation** of computers.

Computers themselves are "**hardware**", i.e. **machines**.

There is an enormous **variety** of software, adapted to many different needs, and new ones are constantly elaborated.

3110

SOLIPSISM ³⁾

The philosophical theory according to which the only "reality" is what is perceived by an **observer**.

A resurgence of bishop BERKELEY's views, solipsism is a frequent risk attached to some systemic interpretations of reality.

One may read for example that "... the Quantum version of the reality principle... asserts that only **observed events** are real" (R. FISCHER, 1992, p.216)

It should probably be better to write "real", or "realized" with quote marks, in order to convey the **understanding** that this does not negates the existence of something "out there".

The same problem may arise out of the notion of **organizational closure**, if it should be believed that the **observer** system becomes "closed" in the **meaning** that all **representations** become **endogenously** generated without any further **reference** to the "outside".

A recent comment by M. MARUYAMA rises the disquieting possibility that our mass electronic **image** culture could lead to quite generalized collective solipsistic attitudes: "This state of mind can be easily produced in an **environment** where everything is artificial, everything is like a theatre stage, every wish can be fulfilled by a push-button, and there is nothing beyond the theatre stage and beyond your **control**" (1994, p.100).

3111

SOLITON ^{1) - 2)}

A solitary **wave**, able to persist in a well-defined shape, for a long distance and an appreciable span of **time**.

According to C. REBBI, a soliton does not fades away because it is submittend to a **topological closure** (1979).

This relates this **phenomenon** to **synergetics** and shows that it must be under the **control** of an **order parameter**.

Accordingly, solitons are forms of spontaneous **self-organization**.

F. David PEAT explains: "... solitons are local phenomena that are constantly sustained through a global **activity**; they are born, persist as **patterns** in **space** and **time**, and then die back into their ground... In the case of solitons it has been possible to analyse a system into relatively independent **parts**, *within the context of the whole*... It is only when **analysis** and **reduction** become absolute and the solitons are taken for truly independent **elements** of reality that confusion sets in" (1987, p.75).

In short, solitons are forms of higher **level organization** emerging from lower **level** interactive **phenomena**.

Solitons have been discovered in many **non-linear** systems (in tidal waves, in vibrating atoms, in electrical circuits, in nerve impulses, etc.) According to F. David PEAT: "It has even been suggested that elementary particles are not in fact the fundamental building blocks of **matter** but are the solitons of an underlying **nonlinear quantum field**" (1987, p.74).

Many more uses of the soliton **model** could probably be found, even possibly in economics and in social sciences.

3112

SOLUTION ¹⁾⁴⁾⁵⁾

The elimination of a **problem** or difficulty affecting some **issue**.

However "there is no free lunch". Any so-called "solution" implies some **costs**. Moreover, as no issue can be isolated from **context** or **environment**, many solutions imply some new problem within the affected **entity**, its environment...or both. In many cases, so-called "**problem solving**" is in fact mere "problem shifting". The problem solver may be either unconscious of the shift or, in some cases, cynical about it.

In short no solution is such if it is merely a zero-sum **game** (or in cases a negative-sum one)

B. BANATHY Sr. once said: "You cannot solve a problem, you only can manage it".

He did not elaborate on his idea, but many contemporary "solutions"are clearly significant examples of bad global **understanding** and **management**

J. WARFIELD made a similar observation and objected to this use of **language** as "a form of linguistic pollution". (pers. comm.)

Moreover, what we do understand as a "solution"depends largely of some implicit **assumptions**, nearly never clearly outlined, nor even at all conscious in many cases.

1. The linear solution :corresponds to a linear view of **causality** and can be legitimately used in simple **problems** of the type: "the left front tyre is punctured. We must change it with the spare one". This remits normally to a sequence of causally simple operations

2. The interdisciplinary solution: Two interconnected simple problems can frequently be solved through consultation between two (or more) specialists. But there is a basic condition: the specialists must understand each other, i.e. each must have at least some **knowledge** of his interlocutor's trade and the way it is relevant for his own work

3. The systemic solution :To begin with, any systemic solution is merely circumstantial and most generally provisional. In this case, "solution"should be understood in a conditional way: the quality of what we understand and decide to do cannot be better than our general grasp of the **situation** within its **context**

4. Solutions in time dimension :Most of the so-called solutions are merely "for now". The ignorance of the **time dimension** and **nonlinear change** leads in most cases to new problems (whose costs are generally paid by somebody else) The time-bomb problem should be taken care of.

→ **Magic bullet; Management; Problem set; Spillover effects; Time; Trial and error; Underconceptualization**

3113

SOMATIC ECOLOGY²⁾⁴⁾⁵⁾

This term has been introduced by the biologist L. BUSS, who writes: "**Evolution** of multi-cellular forms of life is characterized by an increasing sophistication of **cells**, tissues, and **organs**, which perform somatic duties of value to the **individual as a whole**" (1987, p. 53)

In fact, this **behavior** of the **elements** (biological, social or robotic) is coupled with specific, and also more and more sophisticated **communication** means: from physico-chemical **links** to symbolic **language**, through **pheromones** and mimics.

BUSS adds that this **process** requires that: "the cells composing them (the tissues and organs)...limit their inherent potential for proliferation. The propensity for continued **self-replication** has been subjugated to the interest of the whole" (ibid).

This "subjugation" is in fact a bottom-up up-building of an harmonized **hierarchy** and a functional **network**, through reciprocal **constraints** within a shared **environment**.

The complex nature of these somatic ecology processes is also described by J. HOFFMEYER (1995, p. 16-25)

→ **Autogenic systems precursors; Dictyos-telium discoideum; Parallel distributed processing; Stigmergy; Swarm intelligence; Zero-system**

3114

SOURCE^{2) - 4) - 5)}

1. A fixed point that repels all the points in its neighborhood.

A source is the topological opposite to a **sink**. It acts as a kind of negative or anti-attractor.

2. A place or system in the **environment** wherefrom a system receives some specific **inputs**.

Some sources provide absolutely indispensable **resources** to the system, as for example the atmosphere for aerobic **living systems**. Other may provide it with merely useful **resources**, as for example some kinds of non basic foods.

Other sources may be downright noxious for the system, when it is obliged to absorb what they produce: this is the basic problem of contamination.

Systems need maintain a stable relation with their sources, according to their needs. A system which depletes some of its indispensable sources may find itself in danger if the **resource** becomes unable to regenerate at a sufficient rate.

Various systems may compete to obtain **resources** from the same source. This becomes

frequently a cause of **conflict**. Later on it may however lead to some form of negotiation between them and the setting up of some **regulator** whose **cost** is less than the global losses incurred previously.

Ecological **co-evolution** of **populations** of different species reflect the competition for the use of different sources, through ever-changing spontaneous **regulation**.

The **interrelations** between different sources and systems can be easily represented by qualitative **graphs** and also frequently quantified by appropriate **measurement**.

3115

SPACE (the abstract meaning)^{2) - 3)}

"Any abstract mathematical coordinata **framework** or **manifold**, of any number of **dimensions**, in which the **elements** of a **representation** can be ordered" (D. MacKAY, 1969, p.162)

3116

SPACE (the physical meaning)^{1) - 3)}

A. EINSTEIN wrote about two different concepts of space:

"a) space as a positional quality of the world of material **objects**

"b) space as container of all material **objects**.

"In case a), space without a material **object** is inconceivable. In case b), a material **object** can only be conceived as existing in space; space then appears as a reality which in a certain sense is superior to the material world".

EINSTEIN's synthetic opinion however is: "Both space concepts are free creations of the human imagination, means devised for easier comprehension of our sense experience".

He adds: "The victory over the concept of absolute space or over that of the inertial system became possible only because the concept of the material **object** was gradually replaced as the fundamental concept of physics by that of the **field**... that which constitutes the spatial character of reality is then simply the four-dimensionality of the **field**. There is then no "empty" space, that is, there is no space without **field**" (in M. JAMMER, 1957, p.XIV - XVI).

H. MINKOWSKI already in 1908 wrote: "Space by itself, and **time** by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality" (in his lecture "Space and Time" - reproduced in "The Principle of Relativity" - Methuen, 1923, p.75, reedited by Dover).

And, as "there is no space without **field**", it becomes also obvious that **energy** and **matter**, by themselves also fade away as isolated concepts.

P. MANZELLI offers a different, but convergent, view of space: "... the space concept is an essential consequence of the **information/matter interactions**, that depend on the 'auto-organization' of the **dynamical processes** in the physico-chemical **transformations**" (1993, p.333).

Space, like **time**, **matter** and **energy** seems to be an aspect of a global frame for reality (EINSTEIN's field ?) that *our mind* fragments in its utmost effort to understand "the world there outside".

Via the **organization** of the brain **network**, as an **information processor**, these different notions could finally be parts of our constructed **conceptual autopoietic frame of reference**.

3117

SPACE MORPHOLOGY²⁾

R. THOM shows that the **structure** of geometrical space can be established: "In dimension 3, for example a cube, ... we have four types of points: the internal ones, those internal to a side, those on the edges and those on the vertices" (1991, p.117).

This can be generalized appropriately to spaces of any number of dimensions and gives an interesting insight about how our **abstraction frames** surge out of our empirical **perceptions**.

3118

SPACE PERCEPTION³⁾

BERTALANFFY observes that von UEXKÜLL discoveries about the selective **ambients of living systems** relativize "... forms of intuition, considered by KANT as a priori and immutable. The biologist finds that there is no absolute space or **time** but that they depend on the **organization** of the perceiving **organism**" (1962, p.74).

Indeed experiments and even daily experience "... prove that the space of visual and tactual perception is in no way Euclidian. In the space of perception, the coordinates are in no way equivalent, but there is a fundamental difference between top and bottom, right and left, and fore and aft. Already the **organization** of our body, and, in the last resort, the fact that the **organism** is subjected to gravity, makes for an inequality of the horizontal and vertical dimensions" (ibid).

Moreover "... **perception** of space is based on binocular vision, parallax, the contraction of the ciliary muscle, apparent increase or decrease in **size** of an approaching or receding **object**" (ibid., p.79).

Thus space (as well as **time**, **matter** and **energy**), while their existence is doubtless as neatly separated **frames**, are constructed by us as a useful conceptual **frame**, in correspondence with our biological nature.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

I. SILVERMAN, for instance, observes: "Space is the medium in which **Energy** and **Time** expenditures are opposed" (1992, p.137).

3119

SPACE STRUCTURATION (Two dimensional)^{2) - 4)}

The subject was tackled by W. CHRISTALLER (1933 & 1937) and again by A. LÖSCH (1944).

L.F. RICHARDSON, in turn, studied it in an appendix to his "Statistics of deadly Quarrels" (1961, p.139-87), in relation to the influence on wars (foreign or civil) of **population** densities and **locations**.

He defined the notion of "**homoplasy**", i.e. the condition of a closed surface about as broad and as long as possible: "The geometric figure which satisfies completely the property of homoplasy is the circle. It is known, however, that a two-dimensional region cannot be divided into contiguous circles".

Thus, the search for homoplasy becomes the search for the best possible **contiguity**. As already discovered by CHRISTALLER, this is obtained by clustering space hexagonally. RICHARDSON found that 2-dimensional space can be thus partitioned in hexagonal cells in any extension and at any **level** by using the formula:

$$3K^2 - 3K + 1$$

...in which K must be an integer.

Moreover, any hexagonal grid can be fractalized with cells of $1/7$ th, or $1/7^2$ or $1/7^3$, etc. of the area.

The general rationale behind this is that hexagonal clusters express iso-pressure between human **populations** in territory occupation.

CHRISTALLER had also discovered that growing **density** of occupation tends to lead to the appearance of **population** (and services) concentration at the center of every hexagon.

This kind of **implosion** has been explained later by P. ALLEN et al, through dissipative structuration due to massive **inputs** of **energy**, thus adding a dynamic dimension to these **models** of space occupation.

RICHARDSON had however discovered that hexagonal grids could become deformed under some strain, as for example centrifugal or centripetal and gave formula for what he respectively called "central desert" and "central town".

This effect he called "conformal representation" which "allows the honeycomb **pattern** to be strained in all those manners which leave the **cells** almost regular hexagons but no longer all equal" (1961, p.154).

More recently, M. MARUYAMA observed that there is an inhibiting effect exerted by any **element** on **elements** of the same class, which leads to what he called "spacing". He adds: "Spacing contributes to **heterogeneization**" (1994, p.81).

This rule also seems to be valid for biological organisms and in interpersonal contacts (see for instance E. HALL's proxemic research, specially "intrusion distance" - 1959, 1966, 1977).

→ **Hexagonal space filling**

3120

SPACE SYNTAX²⁾

A theory of **space organization** as understood by its users, based on **rules** defined by easiest access from one point or place to another (B. HILLIER, 1996)

Space syntax can be easily represented by **graphs**. Such **models** are useful to modify and enhance general **accessibility** for example in urban **organization** or in roads **networks**. (See also M. HAMER, 1999)

→ **Hexagonal space filling; Occupancy rule; Pattern diversity; Polycentrism; Proxemics; Spacing**

3121

SPACESHIP EARTH¹⁾

"A concept/philosophy for **understanding** and considering the Earth as a spaceship with a limited life supporting system or as a finite, complex **ecosystem**" (UNESCO-UNEP Glossary, 1983, p.25).

In Spaceship Earth, "**survival** requires wise management of limited **resources** and harmonious human and **environmental relationships**" (Ibid).

This concept was introduced in 1966 by K. BOULDING and his short essay has been reprinted in various collections.

3122

SPACE-TIME (Relativistic causal structure of)²⁾

F. HEYLIGHEN comments: "The causal **structure** of space-time, determined by the requirement that causal **processes** be "enclosed" by the light cone, introduces an additional **redundancy** (determining a **topology** on space-time) and a higher-order **distinction** between **processes** inside, outside, or on the light cone while, at the same time, relativizing the **invariance** of the lower-order **distinctions** defining **simultaneity**" (1990, a, p.442).

3123

SPACING²⁾⁴⁾

In a **complex system**, the tendency of similar **subsystems** or **elements** to maintain a minimum **distance** between each others.

As graphically stated by M. MARUYAMA: "You would not build two post offices next to each other" (1994, p. 80). This **phenomenon** is a result of an **inhibiting effect**. Each element or subsystem needs sufficient **resources** within a reach that minimizes the **costs** of obtaining needed **inputs**.

→ **Ecosystem; Niche; Territory**

3124

SPAN²⁾

"The number of entities at the next natural lower **level** in a **hierarchy** which report directly to the entity whose span is to be identified." (T.F.H. ALLEN & T.B. STARR, 1982, p.277).

ALLEN and STARR explain: "... span is observer-defined by what he chooses as natural **boundaries**, that is, what he determines to be the next **boundary** inward or the next **level** down. Span is a matter of appearances, not of **ontological truth**, although appearances involving natural **boundaries** are often shrinking enough..." (p.278).

3125

SPAN OF A SYSTEM²⁾

The number of **subsystems** into which it is partitioned (H. SIMON, 1965, p.65).

SIMON comments: "Thus, a **hierarchic** system is flat at a given **level** if it has a wide span at that **level**. A diamond has a wide span at the cristal **level**, but not at the next **level** down, the molecular **level**" (p.65).

Moreover, SIMON observes that "Most physical and biological **hierarchies** are described in spatial terms... On the other hand, we propose to identify social **hierarchies** not by observing who lives close to whom, but by observing who interacts with whom. These two points of view can be reconciled by *defining hierarchy in terms of intensity of interaction*, but observing that in most biological and physical systems relatively intense **interaction** implies relative spatial propinquity. One of the interesting characteristics of nerve cells and telephone wires is that they permit *very strong specific interactivity at great distances*. To the extent that **interactions** are channeled through specialized **communications** and transportation systems, spatial propinquity becomes less determinative of **structure**" (p.65).

From a more dynamized viewpoint, one may visualize the system as creating the **field**, or even being the **field**.

3126

SPANISH SOCIETY FOR GENERAL SYSTEMS^{*}

→ **Sociedad Española de Sistemas Generales (SESSE)**

3127

SPECIALISTS AND SYSTEMISTS^{1) - 3)}

K. BOULDING stated clearly the necessary relation between the "specific" and the "general": "somewhere between the specific that has no meaning and the general that has no content there must be, for each **purpose** and each **level of abstraction** an **optimum** degree of generality".

Already in 1922, A. BOGDANOV wrote: "No specialist can live completely and solely within his speciality; as a result of contact with other people his **knowledge** and experience inevitably go beyond its **boundaries**" (1980, p.17).

However, still now very severe misunderstandings do exist between specialists and so-called "**generalists**".

Many systemists view specialists as narrow-minded professionals, unable to get out of their own limited field, to understand specialists in other areas and to collaborate usefully in so-called "**multi-, or interdisciplinary**" groups to search for satisfactory solutions for complex **issues** or global **design**.

Conversely, many specialists view systemists as inconsistent Jacks of all trades, meddling uselessly with subjects about which they lack real **understanding**, or even sufficient **knowledge**.

Such a controversy seems senseless.

In our days, nobody can be useful if not specially trained and competent in some limited field. Any good systemist must *also* be a good specialist in some specific field.

However, any responsible specialist may not anymore limit her/himself to the search of some unilateral and narrow solution to some fragment of a problem, risking to create more problems in the **process**.

The true responsibility of systemists is to create a (**transdisciplinary**) **meta-language** of concepts, **methods** and **models**, directed to the general **understanding** of **interconnections** between fields, and to discuss this **meta-language** with the more open-minded specialists, in order to make it more complete and useful.

Conversely the true responsibility of specialists is to abandon the "that is not my matter" attitude, in front of some out of their field consequence of their work, and to accept the **dialogue** (or "multilogue"!) with the systemists, eventually correcting some oversimplifications or unsatisfactory pseudo-general concepts, **models** or **methods**.

→ **Clumpers and Splitters**

3128

SPECIALIZATION through competition¹⁾

Antagonisms between systems are frequently transcended into specialization in a more complex one, in which the antagonists are submitted to, or have accepted, reciprocal limitations.

Rivalries are transformed into **regulated** internal countervailing **feedbacks** which imply, if not **cooperation**, at least reciprocal tolerance.

Specialization can be **functional** or **structural** (as for instance in geographical sectors).

The enhanced **heterogeneity** within the **complex system** gives it a better capacity for **adaptation**.

3129

SPECIFICITY PRINCIPLE (MÜLLER's Law)^{1) - 3)}

There are as many unitary **informations**, qualitatively different as there are different **receivers** units

The groupings, in different ways, of these different **informations**, give their meaning to outside **events**.

3130

SPECTRAL ANALYSIS²⁾

A mathematical technique which permits the discovery of superposed **frequencies** in a curve.

As many different **frequencies** can be made to appear strictly by mathematical treatment, spectral analysis must be used with care.

K. BOULDING for instance, observes that economists have given scant attention to the underlying **cybernetic regulations** in economic **processes** and that: "Perhaps as a result of this failure to take a significant intellectual tool simply because (they) have not made it themselves, economists seem virtually to have lost interest in the theory of **fluctuations** and what work has been done in this has been of an extremely mechanical nature, using for instance, spectral analysis, which is an elegant way of detecting probably nonexistent **cycles** and throws no light on the real **structures** and **processes** which underlie **fluctuations**" (1972, p. 86)

The technique is also known as "**Fourier analysis**", "**Frequency analysis**", or "**Harmonic analysis**".

3131

SPECULAR INTERACTIONS³⁾

J.L. VULLIERME states: "The social composition of individual **behaviors** depends directly from the cognitive reference that each individual makes on himself; but this reference, in turn, necessarily passes through a reference to the way in which others refers themselves to him."

"This kind of mirroring – from here the term "specularity", from "speculum" latin for mirror – is the condition for possible objective **modelization**" (1990, p 153).

→ **"ROBOTS (social)"**

The so-called "objective **modelization**" is thus an intersubjective one, obtained by **consensus** and through a **permanent process** of consensuality. Moreover, this **process** is so automatic as to have remained practically inconscious until the 20th. Century (with some exceptions, as for example, BERKELEY).

The specular **interactions** are obviously an important mechanism of **organizational closure** and **self-organization**.

VULLIERME emits this interesting opinion: "... if some day, truly thinking artificial **machines** do appear, they will necessarily be socialized **machines**, i.e. **machines** able to communicate with others, to construct their **self-reference** through cross referencing with other; and not **machines** able to modify themselves only because they would be previously apt to modelize **objects**" (1990, p.153).

→ **ROBOTS (Social)**

3132

SPECULARITY⁴⁾

"A mode of **complex organization** (verified in anthropo-social systems) whose **dynamics** consists of a tangle of internal **modelizations**" (J.L. VULLIERME, 1990, p.147).

VULLIERME states: "**Complexification** has become an imperative in social sciences, as shown by the "specular theories".

"These theories start from the hypothesis that all anthropo-social **organizations** are based on the "specular **interaction**" of their members, i.e., a crossed cognitive **interaction** (see: "**Cognitive rings**"), such as any **agent** refers to himself only through **reference** to the way that others agents refer themselves to him" (p.148).

Thus the **behavior** of all **agents** is derived from these cross-references.

It seems moreover that:

1. this way to social **complexity** exists also in animal societies, as shown for example by Th. SEELEY's studies on honeybees (1989), and the one of SUSSMAN on the social phase of **Dicystostelium discoideum** (1964).
2. there exists also an indirect way of reciprocal social conditioning, by **observation** of the material results of the **activities** of other members even if these are absent, or even if they already disappeared (see **stigmergy**).

3133

SPEECH ACT¹⁴⁾

Any utterance that can be considered as an **action**.

Examples are: "I warn you" - "I promise you", or if you are a priest: "I marry you". This concept was developed by J. AUSTIN (1962).

Its systemic interest lies in the common **tacit knowledge** by the concerned participants of the relevant "**class** of communicative **actions**".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3134

SPILLOVER COST→ **Commons; Effects (side)**

3135

SPILLOVER EFFECTS²⁾

Also called "**Perverse effects**" by some french sociologists

→ **Effects (Side)**

3136

SPIRALITY²⁾

The characteristic **recursive process** as it appears in the **time dimension**.

The concept of spirality is more adequate that the **circularity** one, in accordance with HERACLITUS saying that we never swim twice in the same river.

It also reflects in a more satisfactory way the dynamics of **fields**.

→ **Helix, Toroid**

3137

SPLITTERS and clumpers→ **Clumpers and Splitters**

3138

SPREADTHINK⁴⁾

A kind of conceptual **pathology** of **groups** unable to reach any "genuine **consensus**, or even majority view toward component aspects of a **complex issue**" (J. WARFIELD, 1995, p.IV).

WARFIELD dedicates a full chapter to the important concept reflected by this neologism, used to explain ineffective thinking in **groups** (p.73-87).

He states that this collective condition is generally neither recognized nor compensated for, and proposes a **method** to correct this type of **situations**.

He writes: "Spreadthink can be viewed as a short name for the content of these two Laws of **Complexity**".

"- The Law of Inherent Conflict – which asserts that no matter what the **complex issue** and no matter what the **group** involved, there will always be significant **conflict** in interpreting what is important in resolving that **issue**.

"- The Law of Diverse Beliefs – which asserts that at the outset of an investigation of a **complex issue**, members of the **group** will have quite diverse beliefs about the **issue**" (p.75)

He explains spreadthink as a result of four other laws, namely:

- The Law of Limits: according to which no single individual is able to obtain an all-embracing **information** and **understanding** about a **complex situation**.

- The Law of Organizational Linguistics "which relates to the inadequacy of organizational **language** to supply the conceptual terminology in which to couch a proper viewpoint of a **complex situation**" (This surely means "of any *specific* organizational **language**")

- The Law of Structural **Underconceptualization**, a result of the use of **methodologies** only appropriate for ordinary simple **situations**.

- The Law of Requisite Saliency which asserts that people find difficult to organize well their ideas around the most relevant aspects corresponding to a specific **situation**.

WARFIELD shows how **Nominal Group Technique and Interpretive Structural Modeling** can be used to discover, and correct spreadthink in order to define an **evaluation** of any **situation** satisfactory for the whole **group** of participants.

3139

SQUEEZING EFFECT^{2/4)}

The pressure of some environmental **factor** on a number of loose **elements**, generally of the same kind.

The general result of the effect is to transform the loose elements into a more or less organized and structured **group**, with some collective **behavior**.

The environmental pressure can be of many different kinds, as in the following examples:

- the decrease of food disponibilities which induces the social state of the amoeba **Dictyostelium discoideum**
- the pressure exerted by some predator on a more or less scattered group of preys
- some collectively perceived danger (fire, gunfire) which produces a panic in a human **crowd**.
- the general underlying factor is the shortening of the distance between the elements, which enhances the possibilities for new and closer **relationships** through a stronger reciprocal **perception**. Squeezing effects seem to be closely related to the appearance of all kind of **languages** (biophysical, biochemical, gestural or spoken) and seem to be the main root of possible further **cooperation**.

→ **Congeries; Crowding effect; Effect (Herd); Effect (Mass); Effect (Positional)**

3140

ST.GALLEN MODEL¹⁾⁵⁾

A view of **management** based on the idea that the business **organization** is similar to a living **social system** (Adapted from F. CAPRA, 1997, p. 76)

This model was evolved by H. ULRICH at the University of St. Gallen in Switzerland (1984), where this work is still forwarded now by Prof.

M. SCHWANINGER (1998, 2001) and his colleagues

It is to be compared with MILLER's **Living Systems taxonomy**, specially at the complexity level of the **Group**, the **Organization** and the **Community**.

This concept includes "many ideas from biology, **cognitive science**, **ecology**, and evolutionary theory". CAPRA notes that "these developments gave rise to the new discipline of "systemic **management**" (Ibid, p. 76)

3141

STABILITY¹⁾

The ability of a system to maintain its **equilibrium** or regain it if temporarily perturbed.

With the exception pictured by a ball resting in the deepest of a well, stability is the result of a **process**. In effect, it depends necessarily on some **cybernetic mechanism of stabilization**.

In K. BOULDING words: "Stability has to be seen as a subspecies of **change**" (1956, p.68). It should never be confused with immobility.

Stability in systems is related to dynamic **equilibrium** and implies **fluctuations** of the systemic **processes** within defined **limits**, with the help of **negative feedbacks** to compensate excessive accelerations or **amplitudes** and **positive feedbacks** to compensate undue slowing down or reduced **amplitudes**. This is **control** by **compensated** or **countervailing regulation**.

"Stable" is thus very far to mean "static". As observed by E. JANTSCH, systems of high **complexity** trade part of their stability for richness in **adaptability** (1975, p.52).

A stable system is thus a **controlled** one – either naturally or artificially and in G. WEINBERG's words: "implies **limits** to the **disturbances** that the system is supposed to withstand" (1975, p.230). But the exact determination of this **level** of admissible **disturbances** is in itself a difficult and crucial matter (Ibid).

T.F.H ALLEN and T.B. STARR explain: "There are several definitions involved:

"a) *Sensu lato*, the general display of persistence in both **structure** and **patterns of behavior**. Here **resilience** is one aspect of stability.

"b) *Sensu stricto*, specifically excludes **resilience** as part of the definition and refers only to the rapidity with which the **equilibrium** is re-established when displacement from the **equilibrium** occurs. Generally systems stable in this sense resist the influence of outside **disturbance** rather than accommodating the influence once it has had its effect.

"c) **Structural stability**, the capacity of a system to display generally the same **emergent behavior** despite **changes** in the interrelationships between its **parts**. In case of an

equation, **structural stability** would be represented by the persistence of general **patterns of behavior** despite **changes** in the equation **parameters**" (1982, p.278).

→ **instability, metastability, and ultrastability**

3142

STABILITY AND COMPLEXITY ¹⁾

Is complexity a favorable or unfavorable factor of stability in systems?

Any very complex system (For ex. an **ecosystem** or a **sociosystem**) offers many alternatives for **adaptations** to environmental **disturbances** or, in terms of ASHBY, a high degree of **variety**.

However this **adaptability** depends on the system's **dynamics**. A very static system has scarce possibilities to use any available **variety**.

On the other hand complexity should not be confused with the excess of redundant and ill-connected **parts**, which use up the systems **resources** for their self-maintenance without enhancing its **adaptability** and can even reduce it.

→ **Conglomerate**

3143

STABILITY AND RESILIENCE ¹⁾

A very high stability is advantageous for a system only if its **environmental** conditions themselves are very stable, since in this case, it will likely be able to maintain its **processes** within their **limits**.

However, when it may have to confront strong, ample and frequent **disturbances**, resilience is a great vantage. In such case, by admitting the risks and **costs** of crossing **thresholds** into other **domains of attraction**, the system may significantly enhance its **survival** potential, even in quite unfavorable conditions. As stated by L. SLOBODKIN: "... **evolution** is like a **game**, but a distinctive one in which the only payoff is to stay in the **game**" (1964).

These **trade-offs** between stability and resilience are of universal interest for **organisms**, species and human **organizations**.

3144

STABILITY AND WHOLENESS ¹⁾

W.R. ASHBY emphasizes that stability (as he defined it: i.e. "dynamic stability"):

"... in no way implies fixity or **rigidity**. It is true that the stable system usually has a **state of equilibrium** at which it shows no **change**; but the lack of **change** is deceptive if it suggests **rigidity**: if displaced from the **state of equilibrium** it will show active, perhaps extensive and complex, movements. The stable system is restricted only in that it does not show the unrestricted **divergencies of instability**" (1960, p.55-6).

This leads him to relate stability to **wholeness**, in the following way:

"An important feature of a system's stability (or **instability**) is that *it is a property of the whole system and can be assigned to no part of it*. The statement may be illustrated by... the practical construction of the thermostat. In order to ensure the stability of the final assembly, the designer must consider:

(1) The effect of the temperature on the diameter of the capsule, i.e. whether a rise in temperature makes the capsule expand or shrink.

(2) Which way an expansion of the capsule moves the lever.

(3) Which way a movement of the lever moves the gas-tap.

(4) Whether a given movement of the gas-tap makes the velocity of gas-flow increase or decrease.

(5) Whether an increase of gas-flow makes the **size** of the gas-flame increase or decrease.

(6) How a increase in **size** of the gas-flame will affect the temperature of the capsule.

Some of the answers are obvious, but they must none-the-less be included. When the six answers are known, the designer can ensure stability only by arranging the **components** (chiefly by manipulating (2), (3) and (5) so that as a **whole** they form an appropriate combination. Thus five of the effects may be decided, yet the stability will still depend on how the sixth is related to them. *The stability belongs only to the combination; it cannot be related to the parts considered separately*" (1960, p.56).

and: "The fact that the stability of a system is a property of the system as a **whole** is related to the fact that *the presence of stability always implies some co-ordination of the actions between the parts*. In the thermostat the necessity for **co-ordination** is clear, for if the **components** were assembled at random there would be only an even **chance** that the assembly would be stable. But as the system and the **feedbacks** become more complex, so does the achievement of stability become more difficult and the likelihood of instability greater" (1960, p.57).

One may wonder about the implications of this last sentence for the contemporary human systems (natural and artificial), which become evermore complex.

3145

STABILITY (Asymptotic) ^{1) - 2)}

The tendency of a system towards a final **state** of absolute stability.

Such a **process** is characterized by the progressive damping with **time** of adaptive **fluctuations** within narrowing **limits**. Absolute stability is never reached (not even through *rigor mortis*) because it results in immediate end of **coherence**, the consequent **breakdown** of the system and the swift dispersal of its **elements**.

This is also true in ecological systems, as shown by Ch WALTER in a critical study of the LOTKA and VOLTERRA prey-predator equations (1954, p.215-217).

Asymptotic stability as a **process** is possible only for some **time**, until some basic **function** of the system undergoes a **disturbance** that throws it out of its stability conditions.

3146

STABILITY (Dual) ²⁾

A form of stability consisting of two different **zones** of stability, or **phases**, separated by a **discontinuity**.

Also known as bi-stability, this condition is proper to numerous physical, biological and ecological systems, and can be also found, at least in a metaphoric sense, in economic and **social systems**.

Bi-stable systems "jump" from one state to the other through a "**catastrophe**".

3147

STABILITY (Dynamic) ^{1) - 2)}

Property of a system that maintains its **structures** and **functions** within well defined and relatively narrow **limits** during a long period of **time**.

K. BOULDING observes: "... it was an economist, Paul SAMUELSON, in his *Foundations of Economic Analysis*, who gave the first clear exposition of the principle that **equilibrium** of any system has to be derived from its dynamic **path** and that we could not find out about the stability of an **equilibrium** from an inspection of the equations of **equilibrium** alone... **Equilibrium** is simply a dynamic **process** in which the dynamic **path** of the system leads to a reproduction in successive **states** of some initial **equilibrium state**. "Staying the same" is simply a special case of "changing" (1972, p.81).

J.de ROSNAY comments: "To maintain itself is to endure. **Negative feedbacks**, by controlling divergent positive ones, tend to stabilize a system and to allow it to last. The system is able to regulate itself.

"To mix stability and **dynamics** may see paradoxical. In fact this link expresses that the **structures** or **functions** of an **open system** remain **self-similar** in spite of the permanent renewal of the systems **components**. This persistence... is dynamic stability. It is found in the **cell**, the **living system**, or the flame of a candle.

"Dynamic stability is the result of combination and readjustment of numerous **equilibria** attained and maintained by the system, as for example the **equilibrium** of internal **medium** of the **organism**... These equilibria are thus dynamic. This imposes however a **distinction** between equilibrium between forces and **equilibrium** between **flows**" (1990, p.117).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Homeostasis as studied by W. CANNON (1963) is dynamic stability in **living systems**.

3148

STABILITY (Dynamic) and CONNEXITY ¹⁾

H. SIMON states that "Interesting results have been obtained showing that dynamic stability of a large class of **complex systems** depends on their **components** connexity: For the lesser **levels** of connexity, they will be stable, but upon a given **level**, they will suddenly become unstable. This **phenomenon** was demonstrated by simulation by GARDNER and ASHBY and later on, analytically proved by MAY".

MAY's result "shows that, among highly interconnected systems, only some quite specific systems will be stable. Because unstable systems have a fleeting existence only, we must expect that many of the effectively observed systems will offer relatively low degrees of connectivity among their components" (1990, p.137-138).

Cohesion rests on connexity. However, while insufficient connexity implies scattering and eventual dislocation of the system, an excess of connexity provokes its freezing. This problem, specially in the very huge systems, seems related to slowdown in **communication** and over-saturation in **communication channels**.

3149

STABILITY (Dynamic) of a flame ²⁾

W. KOHLER writes: "Life has sometimes been compared to a flame (e.g. ROUX, 1914, p.17,p.79). This is more than a poetical **metaphor**, since, from the point of view of **function** and energetics, life and flame have actually much in common. The flame, say a candle, is a **steady state**. The continued existence of this **state** involves a continual supply of potential **energy** which the flame receives as "food" through the wick and as oxygen from the air...

"We light a candle with a match. On the wick there appears at first a tiny flame. This flame grows spontaneously until it attains a maximum **size** and at the same time a certain shape, which then remains unaltered.

"(When) the flame begins to grow... **gradients** are set up both for the food and the oxygen. The flame begins to grow, and these **gradients** increase correspondingly... But there is a **limit** to this **process**. When a certain **size** and a certain maximum of combustion have been reached, any further **growth** of the flame would lead to a higher demand than is compatible with the possible speed of oxygen diffusion from the surrounding air and with that of the food-stream which passes through the wick" (1969, p.34).

The **energy** consumption thus settles at the maximum compatible with the system's nature (in this case *physical*) in relation to the environmental conditions. In an atmosphere of pure

oxygen, this maximum would be higher, but if we place the flame within some enclosure, it burns up the oxygen and dies out. **Dynamic stability** is thus a **transformation** mode of **energy** and is not specific to **living systems** only.

3150

STABILITY (in the sense of LAGRANGE) ^{2) - 5)}

A stability characterized by a strict **periodicity** of the **trajectory**.

This means that **frequency** and **amplitude** must be conserved.

3151

STABILITY (in the sense of LIAPOUNOV) ^{2) - 5)}

Basically, LIAPOUNOV's stability implies that variations in the **initial conditions** do not change the **qualitative behavior** of the system, i.e. allowing for definite **phase transitions** between a **limited** number of qualified possible **states**.

J.L. CHABERT and A.D. DALMEDICO write: "POINCARÉ considered also another concept of stability, which was made clearer somewhat later on by the Russian mathematician LYAPUNOV, and which concerns the difference between a **periodic trajectory** and the neighbouring ones: if the difference diminishes the **trajectory** is stable. The solutions are stable or unstable in relation to certain coefficients which typify them, the "characteristic exponents" (1991, p.570).

These are known as "LYAPUNOV exponents" and defines **trajectories** which maybe **asymptotic**, **periodic** or **chaotic**.

3152

STABILITY (in the sense of POISSON) ^{2) - 5)}

A stability characterized by "the return of a point after some **time**, if not at its initial position, at least to a position as close as one wishes to this initial position" (1991, p.570).

This implies that the **trajectory** should never cross a "no-return" **threshold** of **instability** and that the system should never become **dissipative**.

3153

STABILITY (Levels of) ^{1) - 2)}

No stability is absolute. However, **short**, **medium** and **long term** stabilities can be distinguished in many cases. Of course, **short**, **medium** and **long term** should be defined according to the nature of the system and its **processes**.

Higher levels of stability **embed** shorter ones as their **limit**. As stated by L. DOUGLAS KIEL: "This **understanding** requires a rethinking of the purposes of **forecasting**. Perhaps a more prudent approach to **forecasting** then, should

focus on **forecasting** "symmetry breaking" **events** when existing **structures** break down generating extreme **uncertainty** as to **structural** and **behavioral** outcomes" (1975, p.36).

A good application of this different **forecasting** technique is the chartists analysis of stock markets **trends**. (which does not imply that chartists necessarily understand the rationale of this technique!).

3154

STABILITY (Local) ^{1) - 2)}

The characteristic of a system in which some **parts** are remaining constant at some times.

This concept belongs to W.R. ASHBY (1960, p.171-83).

Any **concrete system** must necessarily present a number of **parts** or show **subsystems** which maintain their stability during various **periods** of **time**. While this stability is generally **dynamic** (i.e. **oscillating**), the **fluctuations** are so slight or slow that they do not notably affect other **subsystems**, thus ensuring the continuity of the system as a **whole**.

Local stabilities allow for the upbuilding of the system's **structures**.

→ **Frozen cores**

3155

STABILITY (Lotka-Volterra model of) ²⁾

C. HOLLING evaluates this **model** in the following way: "... the familiar LOTKA - VOLTERRA **model** includes the simplest and least realistic (terms), in which death of prey is caused only by predators, predation is a **linear function** of the product of prey and predator **populations**, and **growth** of the predator **population** is linearly proportional to the same product. This **model** generates neutral **stability**..., but the assumptions are very unrealistic since very few **components** are included, there are no explicit **lags** or spatial **elements**, and **thresholds**, **limits** and **nonlinearities** are missing" (1976, p.75-6).

In any case, LOTKA and VOLTERRA's work has been a pioneering one. Its critique led precisely to the study of the aspects emphasized by HOLLING and contributed to the emergence of the **concepts** of **attractors**, **stability** and **chaos**, as well as to a better **understanding** of the nature and importance of **nonlinearity**.

3156

STABILITY (Meta-) ²⁾

→ **Metastability**

3157

STABILITY (Neutral) ²⁾

Situation of a system which "... rests at any perturbed condition without tending to return to, or diverge further from the original **equilibrium point**" (J. MILSUM, 1968, p.47).

While this is the case of a marble on a flat surface, neutral stability generally would be quite a unnatural condition in any **complex system**.

3158

STABILITY (Parameter change and)²⁾

According to W.R. ASHBY: "...because a **change** of parameter value changes the **field**, and because a system's stability depends on its **field**, a change of parameter value will in general change a system's stability in some way" (1960, p.77).

"Change of parameter value may result in any **change** which can be produced by the substitution of one **field** for another: stable systems may become unstable, **states of equilibrium** may be moved, single **states of equilibrium** may become multiple, **states of equilibrium** may become **cycles**, and so on...

"...the **relationship**... is reciprocal: in a **state-determined** system, a **change** of stability can only be due to a **change** of value of a parameter, and **change** of value of a parameter causes a **change** in stability" (Ibid.p.78).

3159

STABILITY (Poly-)^{2) - 4)}

"A stability involving many alternatives and sometimes only temporary **equilibria**" (K. KRIPPENDORFF, 1986, p.58).

KRIPPENDORFF explains: "(it) is characteristic of systems involving many weakly interacting **components**. When systems are joined to form larger **wholes**, **communication** among them tends to have the effect of disturbing each other's individual **equilibria**. The **equilibrium** of the **whole** is not merely selective of, and may not even coincide with the **equilibria** of its **parts**" (Ibid).

It is now understood that, as **simultaneous events** in different **parts** of the system cannot propagate instantaneously to the **whole**, local **desequilibria** can never become completely settled.

The effects of poly-stability are seldom understood by managers of economic or political systems, which explains that they in many cases merely try to "catch up".

3160

STABILITY (Poly-) by multiple LOCALIZATIONS²⁾

W.R. ASHBY states: "...in a large polystable system, a whole reaction will be based on **activities** that are both numerous and widely scattered...

"...so a reaction based on numerous and widely scattered **elements** will tend to have more **immunity** to localized injury than one whose **elements** are few and compact"(1960, p.182-183)

ASHBY arrived to this conclusion in relation to LASHLEY's experiments about **memory** traces in the **brain**. This kind of polystability by non exclusive **localisation** may explain how a near complete mental rehabilitation is frequently possible after a cerebral haemorrhage, when not too massive. The same **behavior** is obvious in any human (or insect) society repairing damage after some destructive event.

3161

STABILITY STRATA²⁾

According to E. LASZLO, it appears that **energy flows** "have intrinsic stability in specific **configurations**" (1974, p.207).

He recognizes the following stability strata: atoms, molecules and crystals, macromolecules aggregates, **cells**, multicellular **organisms**, self-contained coordinated **populations (ecosystems)**.

We would add **social systems**, maybe even in the very basic sense that every stability stratum corresponds precisely to the shaping of social **links** within **wholes**.

The concept of stability strata also appears in C. BRESCH's more recent work (1987), and at least in an implicit way in various other authors, as for example J. MILLER's **levels of organization in living systems**.

3162

STABILITY (Structural)²⁾

"The capacity of a system to maintain the same essential **patterns of behavior** despite some modification in the structural **interrelations** between the systems **parts**" (T.F.H. ALLEN & T.B. STARR, 1982, p.278).

The concept of structural stability was introduced in 1937 by the Russian mathematicians A. ANDRONOV and L. PONTRIAGIN. It led and is still leading to considerable developments in the **topological** study of the **complex systems stability**, as for example **catastrophe theory** (THOM and ZEEMAN), the various types of **attractors**, and **deterministic chaos**.

As stated by L. LÖFGREN: "A system is structurally stable if the **topology** of its **trajectories** is preserved under sufficiently small **perturbations**" (1974, p.78).

For K.B.DE GREENE: "A **function** or system is structurally stable if such qualitative properties as numbers and kind of **critical points** and **basins of attraction** remain unchanged after a sufficiently small **perturbation**" (1990, p.54).

Small modifications correspond mostly to small **perturbations**. Structural stability is compatible with more or less **periodic changes of state**, i.e. with **ergodicity**.

According to S. DINER: "A structurally stable **dynamic system** is... a **topologically** stable system, i.e. a system whose **phase portrait** undergoes few modifications and remains topologically **self-similar** under the influence of

lesser **perturbations** in its movement equations...; (it) maintains its essential qualitative properties when affected by a slight **perturbation**" (1992, p.360).

This is the case for merely local **instabilities**.

To the ALLEN and STARR's definition and LÖFGREN's comment, which correspond to confirmed stable systems, one should aggregate the following comment by K.DE GREENE: "... structural stability in **dissipative-structure** theory refers to the **response** of the system to the addition of new **elements**" (1988, p. 291).

And: "The structural stability of any existing **deterministic system**, potentially capable of **evolution**, is continually tested by both internal and external (**random noise**) **fluctuations**" (DE GREENE, 1994, p.14). On the contrary: "The system is structurally unstable if mutations (genetic, scientific, technological, "great persons" – my terms) can multiply and take over and modify system **processes**" (Ibid).

R. ROSEN sees a practical use for the concept: "Structural stability is a general **framework** for comparing one **description** of a **class** of **objects** against another **description**, usually in terms of measures of **closeness**" (1991b, p.480).

3163

STABILITY (Struggle for)^{1) - 4)}

By its own nature, any system tends to remain within a defined stability **boundary**, which ensures its **homeostasis** and permanence, as long as no basic **change** in its **environment** throws it forcefully out of its **domain of attraction**.

However, as noted by C. HOLLING, **human systems** (which are increasingly destabilizing natural ones) must also increasingly: "... learn to live with **disturbance**, live with **variability** and live with **uncertainties**" (1976, p.91). This is the price to pay for **survival**.

We must accept that we are moving away from **homeostatic** stability and that the more we move away from it, the more potentially dangerous the **situation** of our systems, and the more difficult to turn back toward "classical" stability.

The struggle for stability implies for our **dissipative** and **emergent** systems, the search for a higher **level** stability, maintaining **resilience** by creating the possibility to switch, when needed, from one **domain of attraction** to another, within a blown up global stability **domain**.

A typical case where such ideas should be applied is the necessity to design alternative **strategies** in our fight against agricultural or pathological pests.

3164

STABILITY (Ultra-)→ **Ultrastability**

3165

STABILITY CONDITIONS¹⁾

Stability being a basic need for complex dynamical systems, a good **understanding** of stability conditions is very important.

Systems may resist destabilization in different ways:

1/ By the use of internal devices as for example:

- **regulators** and **controls** which adapt the system to the environmental variations (in a more or less statistical way)
- **redundancy**, which may allow one **component** or **subsystem** to replace another one, not able to function correctly
- **variety**, which offers to the system the possibility to select a specific response within a number of possible ones.

2/ By some **pre-adaptation** to a definite **environment** specially favourable:

- By avoiding excessive **specialization** in order to be able to adapt itself to different types of **environments**
- By acquiring the capacity to modify the **environment** in a way better suited to its needs.

All these conditions aim at the **maintenance** of the **identity** and permanence of the system. In the case of giant **fluctuations** and **dissipative structuration**, stability is irretrievably lost, but may be recovered for the benefit of the newly structured system which will possibly replace the former one.

3166

STABILITY MARGIN^{1) - 2)}

The values comprised between the uppermost and lowest **fluctuations thresholds** of some **parameter** critical for the **survival** of a system.

ROSENBROCK and Mc MORRAN, quoted by B. PORTER state, for instance: "... an essential requirement for most industrial **control systems** will be that **changes** of **loop gains**, between zero and the design values and in all combinations, should leave the system with an adequate stability margin" (1976, p.227).

As observed by these authors "... **optimality** does not insure this" (Ibid). (**Optimality** being understood, as it too frequently is the case, as maximality: productive **optimality** is not the same as systemic **optimality**).

Furthermore, a well managed system should ideally remain well within the **limits** of its stability margin, and avoid nearing to closely its **thresholds** of stability, in order to avoid too high **regulation costs** and sometimes very high risks.

3167

STABILIZATION²⁾

If a network is repeatedly disturbed by a regular "**stimulus**" or by a statistically homogeneous "**noise**", it will tend to set its **switches** so that it is less, rather than more, disturbed by it (W.R. ASHBY, 1960, p.5.).

"The property has been demonstrated on the **homeostat** (Ibid)..."

"It depends on the fact that **patterns** that are much disturbed by the **stimulus** will have a large **chance** of being disrupted, while those that are little disturbed will have only a small **chance** of being disrupted. Every **stimulus** or **noise** thus tends differentially to disrupt these **patterns** that are specially sensitive to it. The end-result is that the **machine** tends, if repeatedly stimulated, to become unresponsive to the **stimulus**" (1958, p.5).

ASHBY states: "In the cerebral cortex this **phenomenon** has been long known as "**habituation**". It is in fact not restricted to the cerebral cortex but can be observed in every tissue that is capable of **learning**" (p.5).

In human systems, a similar **process** leads to **routine-like behavior**.

3168

STABILIZATION after a bifurcation²⁾

Stabilization as described by ASHBY can be maintained only inasmuch as the perturbing **stimulus** does not lead to a giant **fluctuation** leading it **far away from thermodynamic equilibrium**, and the possible crossing of an **instability threshold**, leading to a **bifurcation**.

When the system is thus transformed, it may however reach a new **level** of stability.

Bifurcation points delimit in this way the stages of the system's **evolution** or **history**.

3169

STABILIZATION by COMPENSATION¹⁾

The stabilization of a **complex system**, that may be submitted to **chaotic dynamics** is a difficult endeavor.

R. ROSEN proposed to base such stabilization on a sufficient **knowledge** of the "... units of **function** and **homology** of **organization**, rather than on units of **structure**..."

"A corollary of this kind of viewpoint would be an insight into **mechanisms** by which **changes** of **state** of all kinds of systems could be directed (or **controlled**) through the external enhancement of the stabilizing or destabilizing forces inherent in the system (The inhibitory or excitatory factors respectively). Indeed, we can intelligently apply **controls** only when these factors and their dynamical **roles** have been identified, whether that be in human physiology (i.e. medicine), in **ecology**, or in socio-political or economic systems" (1974, p.173).

ROSEN himself admits that this "... is not a finished piece of scientific activity ready for applications, but only a program for such activity, a **strategy**" (Ibid).

Indeed, the possibilities of correction of **chaotic dynamics**, for example, remain still largely in 1997 a "terra incognita".

The alternative use of **inducers** and **repressors**, as observed by ROSEN, or in **cybernetic** terms, of combined **positive** and **negative feedbacks** are possible **mechanisms** for stabilization. But the main point remains the need for a sufficient **knowledge** of the *natural* dynamics of the interested system.

A closely related view is stabilization by **competition**, proposed by M. EIGEN and P. SCHUSTER within the frame of their **hypercycle model** (1979, p.VI).

3170

STABILIZATION STANDARD²⁾

"The **coded** instructions that indicate the **level** of **operation** to be maintained by the **programs** of a **controlled system**" (J.Z. YOUNG, 1974, p.299).

Standards may be embodied within the **program**, which is generally the case in **artefacts**. In natural systems, they must in general be learned. This is – at least partially – the case in biological and social **human systems**.

From a biological viewpoint, YOUNG notes that: "Hereditary standards are basically defined by the genetic **program** and then embodied in certain **parts** of the **brain**, for instance the hypothalamus".

3171

STAKEHOLDER^{1) - 4)}

"Any individual, **group**, **organization**, institution that can *affect* as well as *be affected* by an individual's, **group's**, **organization's**, or institution's *policy* or *policies*" (I.I. MITROFF and H.A. LINSTONE, 1993, p.141).

The authors comment: "The bigger, the more complex the **problem**, the more it is likely to involve a wider array of stakeholders" (p.141).

In a very general way, **issues**, **problems** and **situations** are considered within a quite restricted ring of stakeholders. This leads to quite negative consequences:

- the matter under consideration is insufficiently described and understood (**underconceptualization**)
- **decisions** are made or plans established which do not take in account some important aspects
- As a result, they may lead to new **problems**, or even the resurgence of the same ones
- Stakeholders who were not called to participate and feel harmed or simply do not understand the way matters are managed, become diffident or even hostile, do not lend their collaboration and possibly will sabotage.

Identification of the stakeholders is thus a previous and very important step in any **design, planning or decision making process** (see hereafter).

A most important characteristic of stakeholders is that they have **assumptions** about the **problem**, in many cases implicit and unconscious, or at least not overtly declared. It is necessary to make these **assumptions** appear clearly.

MITROFF and LINSTONE show how to establish **maps** of stakeholders **assumptions**, in a qualitative and quantitative way (p.144).

→ J. WARFIELD'S works.

3172

STAKEHOLDER ANALYSIS ^{1) - 4)}

A technique, described by M.C. JACKSON, that "asks each **group** to identify the key individuals or **groups** on whom the success or failure of their preferred **strategy** would depend. This involves asking questions such as : Who is affected by the **strategy**? Who has an interest in it? Who can affect its adoption, execution or implementation? And who cares about it? For the stakeholders identified, each **group** then lists what assumptions it is making about each of them in believing that its preferred **strategy** will succeed. Each **group** should list all the assumptions derived from asking this question of all the stakeholders. These are the assumptions upon which the success of the **group** preferred **strategy** or solution depends".

A second technique is "assumption rating": "For each other listed assumptions, each **group** asks itself:

- How important is the assumption in terms of its influence on the success or failure of the **strategy**.
- How certain are we that the assumption is justified" (1992, p.143).

→ "Assumptional analysis"; "Nominal Group Technique".

3173

STANDARD ¹⁾

A set of characteristics that define the normally accepted conditions, general **structures** and functionality of a system.

This applies to many different kinds of systems, as **artifacts**, natural or engineered controlling devices, behavioral **rules** of individuals, or human **groups**.

Evaluations of business practice and results, or financial situations are also submitted to specific standards.

3174

STASIS ^{2) - 5)}

1) The balance between various forces in **equilibrium**.

Stasis may appear at some **nodes** in permanently interacting **fields**. It could be the origin of stable **forms** and **homeostasis** (d'Arcy THOMPSON, 1916 – C. LAVILLE, 1950).

2) The state of **stability** reached by a species after a phase of swift **evolution**.

The concept has been introduced in paleontology and **evolution** theory by St. GOULD and N. ELDREDGE, who speak of "Punctuated **equilibrium** and macroevolution" (1993, p.223).

It seems to be a mere synonym for **homeostasis** (in **populations**). The authors write: "... stasis does not signify rock-hard immobility, but **fluctuation** of little or no consequence" (p.226).

The curious parallelism with PRIGOGINE's **theorem of minimum entropy production** from one side, and his **dissipative structuration** in **far-from-equilibrium systems** from the other, is striking and should be investigated.

3175

STATE (Critical) ²⁾

The state at which a specific **change** in the value of the **variable** produces a **discontinuity** (or jump) in a **step function**. (After W.R. ASHBY, 1960, p.91).

ASHBY gives as an example: "The critical state of an electric fuse is the number of amperes which will cause it to blow" (p.91)

There are also numerous mechanical and physiological examples of such jumps or **discontinuities** leading instantaneously to a quite different **state** of the system.

This type of events is akin to THOM's **catastrophes** but somewhat different to the critical state in **composite systems**.

ASHBY's critical state may be the harbinger of the systems **breakdown**, a totally irreversible **event**, while **criticality** in **composite systems** tends to self-reconstruction. However, even in strongly **integrated systems**, the **step function** may undergo periodic returns to the critical state.

3176

STATE DETERMINED ²⁾

The character of the future of a system whose present state and **behavior** are known.

Only simple **causal** and rigorously **deterministic** macroscopic (Laplacian) systems – which are the very rare exception – are strictly state determined. Practically neither the state, nor the **behavior** of a **complex system** are ever **perfectly** known. The concept, and the mathematics that describe it, are however useful within the brackets of **situations** considered stable in which both conditions are reasonably well known.

Ergodic systems are state determined only in a general stochastic sense... and beware of **deterministic chaos**!

3177

STATE EQUATION and STATE FUNCTION ²⁾

J.L. LE MOIGNE clearly distinguishes both, as follows: "A systems **state function** allows to understand its structural **dynamics**, while its **state equation** expresses its cinematics.

"The state equation implies the availability of the register of **parameter programs** of a given **structure**, which could be used as the framework for the **description** of the "Système Général"'s **trajectory**. The structural state **function** implies changing the frame of reference. (in this case) The **structure** is variable, as it is processed by the **fields** of variable intensity which affect the system. The frame of reference is now the environment, plastered with **morphogenetic fields**" (1977, p.172).

It would certainly be interesting to harmonize the concepts of state function with those of **organizational closure** (F. VARELA), **hypercycle** (M. EIGEN) and **slaving principle** (H. HAKEN).

3178

STATE (Initial) ²⁾

"The first state in a **line of behavior**" (W.R. ASHBY, 1960, p.20).

Starting from the initial state, "A **line of behavior** is specified by a succession of states and the **time-intervals** between them" (Ibid). This seems to be a simplified **deterministic** view.

However, initial states are generally complex, made of various (or numerous!) **interacting initial conditions**. J. CASTI observes that it is "impossible, practically speaking, to know a system's **exact** initial state; it is effectively uncomputable" (1994, p.114).

→ Garden of Eden

3179

STATE of a SYSTEM ¹⁾

"A recognizable condition of a system (G. PASK, 1961, p.117).

"The **set** of numerical values which the **variables** of a system have at a given instant" (W.R. ASHBY, 1960.2, p.16).

"The **set** of relevant properties of a system at a moment of **time**" (R.L. ACKOFF, 1972, p.84).

"A particular **pattern** of **relationships** existing among the **components** and the particular filtering condition of the **boundary**" (K. BER-RIEN, 1968,p.32)

Such generally **synchronic descriptions** – very complex in some cases – take their full sense only when repeated many times at successive instants, i.e. when becoming **diachronic**. Some features of the systems successive states may be conserved or may reappear periodically or irregularly, which comes to reflect precisely the systems identity: Multiple **stationary states** are possible.

While, according to H. PRAEHOFFER the present state "... represents a **memory** of the past of the system" (1991, p.292), such **memory** is frequently in part or totally illegible. The claim to be able to compute the future of a system "... just knowing the current state and the future **inputs**" (Ibid) seems to be in most cases a Laplacian fallacy.

The study of specific **transitions** from one state to a sequence of the other states through **time** is a common **method** to learn about the systems **behavior**. However, even the **observation** of only one instantaneous state may bring some **knowledge** of the system to the **observer**, as he usually relies on connectable **knowledge** obtained from previous experiences. In ASHBY's words: "If he sees two cogs enmeshed he knows that their two rotations will not be independent, even though he does not see them actually rotate" (1960, p.19).

Nevertheless ASHBY hastens to add: "... the unexpected sometimes happens; and the only way to be certain of the relation between **parts** in a new **machine** is to test that relation directly" (Ibid).

From a quite different viewpoint, E. LASZLO states: "The fact is that systems in the real world can exist in one of three types of states. Of these three, one is radically different from classical conceptions: it is the state **far from** thermal and chemical **equilibrium**. The other two states are those in which systems are either **in equilibrium** or **near it**" (1987, p.20).

The first of these two is the maximum **entropy** one,... when the system ceases to be a system. The other one is the common state of **dynamic stability** through **fluctuations** constrained within **limits**.

3180

STATE (Recurrent)²⁾

Situation of a system at a given **time** which is repeated at other instants.

Such a repetition is never perfect. It may be a result of the **invariance** of most **parts** of the system or of the reconstruction of a former **state**, through some **cycle** or **hypercycle**. For example the skeleton of a living vertebrate remains without significant **changes** at **macroscopic scale**. However, this is the result of a cyclical renewal of its **elements**.

Or, in a manufacture the state of the stock of raw materials or goods at some moment may be similar to an previous state, after use, sales and restocking.

3181

STATE SPACE²⁾

"Any n-dimensional space containing points representing the state **description**... of a system".

This formal definition has been given by M. TODA and M. SHUFORD (1965, p.26).

R. ROSEN clarifies the concept as follows: "The totality of all possible states of the system, meaning the totality of different aspects the system can assume *for us* at an instant of **time**, forms a **set** called the state space of the system" (1972, p.50).

T. F. H. ALLEN and T. STARR consider more specifically the **observer's** viewpoint and describe as follows the state space: "A **mode of description** of system **behavior** where, at each point in **time**, the system is described by the position of a point inside a space the dimensions of which are axes relating to the various systems attributes expressed as states (as opposed to derivatives)" (1982, p.278).

An interesting point: The state space is actually a **space-time frame**.

F. HEYLIGHEN gives a shortened definition of the state space: "The **set** of all possible states (of the system)" (1990a, p.426).

3182

STATE (Stable)²⁾

In a **dynamic system**, a state that can be maintained in general terms.

Absolute stability is a purely theoretical condition for any system, because it must always be capable of adapting to even slight **variations** of its **environment**.

A stable state is thus a state permanently constrained within a more or less narrow **channel of fluctuations** which do not impair its **structures** and **functions** in a noticeable way.

3183

STATE (Stationary)²⁾

"The state in which **inputs** are exactly equal to losses and in which **stores** remain stable" (Adapted from H.T. and E.C. ODUM, 1976)

This state is characteristic of **dynamic stability** and generally a result the system's own capacity to **regulate** its intakes and **outputs**. It is a near-synonym for **steady state**.

3184

STATE TRANSITION²⁾

The cross-over from one state to another in a system.

This cross-over can be strictly determined, probabilistic as in **ergodic systems**, or mean a deep change in the nature of the system, as in **chaotic dynamics**.

For the **purpose of modelling** along **reconstructability analysis** lines, G. KLIR introduces the **state-transition system**, "defined in terms of a **set** of overall states based upon a particular **mask** and a specification of conditions for transitions between these states. Epistemologically highest in this early version of the **hierarchy** is a **structure system**, which is defined as a **set** of interacting **behavior** or state-transition systems" (1991, p.345).

The **mask** represents the intentions of the **modelizer**, in relation to her/his specific interests.

3185

STATE-DETERMINED BEHAVIOR²⁾

G. PASK, reflecting ASHBY's views, writes: "A behavior is state determined if an **observer**, knowing the state at *t*, is able to predict the state at *t*+1 with certainty." (1961, p.28).

He rephrases it thus: "a behavior is state-determined if $X(t+1)$ depends in a unique fashion upon $X(t)$ and, in the **phase space**, this means that the path describing a state determined behavior does not **bifurcate**". (Ibid)

The contrary of state-determined behavior is thus **chaotic behavior**.

3186

STATES (Interconvertible)²⁾

The states of a system that may replace each other without affecting its global **stability**.

The concept, quoted by R. MARGALEF, was introduced by R. Mac ARTHUR (1955) (1980, p.62).

When numerous, interconvertible states increase the system's **stability**. This may generally be observed in **networks**, where **information** is widely distributed in many more or less **redundant circuits**, thus allowing for numerous equivalent states and avoiding the danger of **information** loss should one or even various **circuits** become disabled.

3187

STATIC or DYNAMIC VISION^{1) - 3)}

According to J.de ROSNAY "To the opposition between "analytic" and "systemic" we must add the opposition between static and dynamic vision".

He compares both in the following table:

Static Vision (simple systems)	Dynamic Vision (complex systems)
Solid	Fluid
Force	Flow
Closed system	Open system
Linear causality	Circular causality
-stability	-dynamic stability
-rigidity	-steady state
-solidity	-turnover
Equilibrium of forces	Equilibrium of flows
Type: Crystal	Type: Cell
Behavior of the systems	Behavior of the systems
-predictable	-unpredictable
-reproductabl	-non reproductable
-reversible	-irreversible"
(1975, p.112)	

Some of these items could be objected:

1. Generally speaking, there are no "simple" systems. What may be simple is some **function** in a system or some so-called "natural laws" as for example in Newtonian mechanics.

2. The opposition between **closed** and **open systems** is artificial. Any **concrete system** is open *and/or* closed according to its specific and timely necessity.

3. The **behavior** of **complex systems** is generally *more or less* predictable (or unpredictable).

4. As to **reversibility** of any **phenomenon**, it exists only in the *models*. The **2nd. Principle of thermodynamics** forbids it in real processes and systems.

3188

STATIGENESIS²⁾

The **stabilization phase** of a newly emerged type in an **evolutionary process** (W. SCHWEMMLER, 1991, p.152)

3189

STATIONARY PROCESS²⁾

A **process** of **energy transformation** that remains stable during a certain lapse of **time**.

W. KOHLER writes "...there are two classes of stationary processes, one with which a minimum, and another with which a maximum of **energy** is associated" (1969, p.67).

We thus should avoid speaking of *equilibrium* in the physical sense of the word.

Stationary processes are indeed an essential aspect of the **thermodynamics of irreversible systems faraway from equilibrium**.

The stationary process is closely linked to the **steady state**, which is its result.

3190

STATISTICAL SIGNIFICANCE^{2) - 3)}

The confidence degree sustained by a statistical **inquiry** which shows a sufficient **divergence** from purely **random effects**.

The matter is to determine what is a "sufficient **divergence**". On the borderline, some significant **effect** may seem to emerge, but may also remain somewhat (or largely) hypothetical.

On the other hand, statistical significance must be interpreted, i.e. given a *meaning*. At roulette, a 18/20 appearance of red would be statistically significant. But what does it mean? Has somebody "nursed" the wheel? which way? Why?, etc... These are systems problems.

From a systemic viewpoint, as stated by W.D. GROSSMANN and K.E.F. WATT: "... several **phenomena** of great recent importance are strongly dependent on the **behavior** of a very small proportion of all individuals, at the tails of frequency **distribution curves**. AIDS became a pandemic in part because of the atypical **behavior** of a tiny proportion of all individuals, not the average population-wide **behavior**" (1992, p.20). The authors give various other examples

of the shortcomings in the use of statistical average values (and of grossly misleading financial accounting (see "**Patrimonial accounting**").

This problem reflects an insufficient **understanding** due to excessively narrow **frames of reference** used to give significance to mere **data** and **information**.

3191

STEADY STATE²⁾

"A **time-independent state** of an **open system** in which all macroscopic quantities remain constant, although microscopic **processes** of the **input** and **output** of **matter** go on continuously" (I. BLAUBERG et al., 1977, p.47).

L.von BERTALANFFY describes the steady state in the following way: "An **open system** may attain (certain conditions presupposed) a **time-independent state** where the system remains constant as a **whole** and in its **phases**, though there is a continuous **flow** of the component materials" (1969, p.71)

"Time-independent" seems unfortunate **semantics**. (see hereafter)

BERTALANFFY adds however: "Steady states are **irreversible** as a whole, and individual **reactions** concerned may be **irreversible** as well. A **closed system** in **equilibrium** does not need **energy** for its preservation, nor can **energy** be obtained from it (NOTE: This is indeed the *isolated system*, perfectly disordered in its final state, as prescribed by the **2nd. principle of thermodynamics**).

"To perform work, however, the system must be, *not in equilibrium, but tending to attain it*" (Ibid).

(The German term for steady state, introduced by BERTALANFFY, is *Fließgleichgewicht*).

BERTALANFFY, in coincidence with PRIGOGINE, states: "a) Steady states in **open systems** are not defined by maximum **entropy**, but by the approach of **minimum entropy production**. b) **Entropy** may decrease in such systems. c) The steady state with minimal **entropy production** are, in general, stable. Therefore if one of the systems **variables** is altered, the system manifest **changes** in the opposite direction. Thus the **principle of LE CHATELIER** holds, not only for closed but also for **open systems**" (1969, p.78).

No steady state can be maintained without a continual expenditure of **energy**. Such **energy** must be obtained from the **environment** and is degraded as it is used by the system in order to maintain its **functions** and **structures**.

As observed by E. LASZLO a *steady state* system should be clearly distinguished from a *static* one.

In LASZLO's words: "... steady states are not **static** states, but ones which represent a **level**

of **equilibrium** between the internal **constraints** among the systems **components** and the forces acting on it from its **environment**. KATCHALSKY and CURRAN have shown that systems characterized by fixed internal **constraints** and exposed to unrestrained forces in their **environment** tend to produce countervailing forces that bring them back to the **stable states**, since the **flow** caused by the **perturbation** has the same sign as the **perturbation** itself".

This is a kind of generalization of **LE CHATELIER Principle** to **dynamic systems**. It implies that steady-state **behaviors** are **periodic**, or at least quasi-**periodic** (no **living system** could be static and survive).

LASZLO also proposed to replace "steady" state by "optimum" states, but he was not followed (1974, p.50).

BLAUBERG, SADOVSKY and YUDIN state: "Under certain conditions an **open system** may reach the steady state, as opposed to a **closed system** which, left to itself, *must* reach the state of **equilibrium**" (1977, Ibid).

However some caveats are required:

1/ **-Equilibrium** is static or dynamic. A static **equilibrium** would imply a total absence of movement, at least at the **observation level**. A **dynamic equilibrium** admits **fluctuations** around an average **level**.

2/ **-A steady state** is possible only in an **open system** (which admits **flows** of **inputs** and **outputs**). As to the "**closed**" system referred to, it should be better **semantics** to call it "**isolated**" system, (i.e. the purely abstract system in which the **2nd. Principle of thermodynamics** strictly reigns).

3/ **- "Macroscopic" and "microscopic"** should be precisely stated in each case.

4/ **- "time-independent"** should not be understood as "outside the **flow** of **time**", which is obvious within the frame of **thermodynamics of irreversible processes**.

D. KATZ and R.L. KAHN state: "Though the tendency towards a steady state is in its simplest form **homeostatic**, as in the preservation of a constant body temperature, the basic principle is *the preservation of the character of the system*. The **equilibrium** which **complex systems** approach is often that of a quasi-**stationary equilibrium**, to use LEWIN's concept (1947). An adjustment in one direction is countered by a movement in the opposite direction and both movements are approximate rather than precise in their compensatory nature. Thus a temporal chart of **activity** will show a series of ups and downs rather than a smooth curve" (1969, p.97).

→ **State (Stationary)**

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

3192

STEADY STATE and ENVIRONMENT^{1) - 4)}

The steady state of a system can be maintained only as much as its **environment** remains mostly **homeostatic**, i.e. characterized by a rate of **change** very inferior to the adaptive capacity of the system. This is consonant with:

- ASHBY's **Law of requisite variety**
- VENDRYES' concept of **counter-aleatory reserves**

Furthermore, the system must be very small in comparison with its **environment**, as its own **transformations** should not disturb it seriously.

An interesting example is the relatively small total mass of the living beings, compared with the total mass of the planet. Thus, these **living systems** are able to maintain their steady state. However, the enormous power of the human mass presently growing on the planet, could possibly alter some aspects of the global steady state of the latter.

In any case, the steady state of a system involves a **set** of permanent imbalances between the system and its **environment**.

3193

STEERING^{1) - 2)}

The guidance of a system.

Steering is a not too clearly understood **cybernetic concept**, even if it corresponds to the very original name of **cybernetics**. (Kybernetes = Helmsman).

In engineering, steering devices are constructed ad hoc. However, many of them must still be piloted.

In **human systems** too (enterprises, **organizations**, nations), in principle, steering implies the presence of a helmsman and some **power device** or **subsystem** to help him in his task.

Steering also implies willful **control** of the system by the helmsman, with the *purposeful* intention to drive it toward some **goal**. It is a "**control for**" case.

There are however some difficult question marks:

- Are systems really **governable**? And, if so, to what extent?
- Why and how does a helmsman reach a power position?
- How does a helmsman acquire the basic **concepts** and **methods** he applies in his steering action?
- Why and how do the power devices become established (or overthrown)?

There are until now no clear answers to these questions and the most recent **changes** in socio-political systems (f. ex. the rise and fall of the so-called Sovietic system), while profusely, *described*, are still widely unexplained in depth.

3194

STEERING (Self-)^{2) - 4)}

The automatic **self guidance** of a system.

If social systems are **autopoietic** and in **dynamic equilibrium**, it could be conjectured that their steering by leaders is, at least in part, an illusion. The leaders who become powerful could merely be those who understand, or even merely perceive, the basic **trends** and needs of the system at some precise moment, and know how to translate them into proposals and projects. On the contrary, the would be leaders who do not interpret correctly the needs of the system, would find themselves blocked by its resistance to the **changes** they propose.

However, if **social systems** are evolutive and **emergent** – as it seems to be the case at some moments in history – then the **random** appearance of some or other leader in such a system in a **far-from-equilibrium situation**, could be determinant for the **emergence** of a more **complex system** at a **bifurcation point**.

The whole subject was treated in "Sociocybernetic paradoxes" – Eds. F. GEYER and J. van der ZOUWEN (1986)

→ **Governability**

3195

STELLAR TYPE SYSTEM^{1) - 2)}

A. MALINOWSKY proposed this concept according to which an **integrated system** maintains a maximum coordination through a central **link**, or **subsystem**, uniting and controlling the whole of the internal **organization** of the system. *Only this* central **subsystem** is tied up in an evolutive way. This means that eventual innovative characteristics within the dependent **subsystems** are allowed only if they do not contradict the **constraints** imposed by the central **subsystem** (See BLAUBERG et al, 1977, p.218)

The apparent contradiction between **autopoiesis** and **evolution** seems thus eliminated. **Evolution** is still possible, but only within the **limits** of the already strictly fixed characteristics resulting of former **evolution**.

By the way, this explains why there is no "way back" in **evolution**: it is never possible to undo what has been done. In **parasitism** for example, even when various functional **subsystems** are eliminated or reduced, the basic nature of the parasite is not altered.

Conversely, a new adaptive device, may very well be quite innovative and solve in a completely unexpected way a seemingly insoluble problem: man has no wings, but he may "fly", for example using a Delta wing.

3196

STEM²⁾

"A line of **communication** in a **hierarchy**".

"Stems connect higher and lower **holons** in **hierarchical structures**". (T.F.H. ALLEN & T.B. STARR, 1982, p.278)

3197

STEP FUNCTION

→ **Function (step)**

3198

STIGMERGY^{1) - 2) - 4) - 5)}

The alternate and reciprocal transfer of structural and/or functional **information** from individuals to the system they are **part** of, or of the system to its **environment**, and conversely.

This notion was introduced by the French entomologist P.P. GRASSÉ (1959), who generalized it from the growing **interactions** he observed between the activities of the members of some insect societies (termites), as a result from the also growing **perception** by individuals of the results of these activities. The stigmergy **process** in these insects includes two phases. The first one is uncoordinated deposition of material on the available surface. However, the termites diffuse a specific scent at the construction places, which acts as an attraction factor where the activity is important. This provokes a more ordered concentration of insects, leading in turn to coordinated construction work.

PRIGOGINE found that stigmergy is a specific case of **order by fluctuations** and emergence of **order parameters** (1976, p.113-4).

Th. SEELEY observes: "The use of the *shared environment* as a **communication** pathway has certain attractions, including easy asynchronous **transfer of information** between individuals and virtually automatic **transfer of information** between any two individuals sharing some portion of the nest..."

"Because the **process of integration** of a **group** is largely a matter of **information flow** from **group** to individuals, it may be that **information flow** through the *shared environment* has been natural **selection's** principal technique of **integration** in building **superorganisms**" (1989, p.550).

Indirect **information** by environmental cues and **coalescence** of collective oriented **behavior** seem to be a most important and quite general motor for **progressive integration**. This **process** is also obviously very common and active in human societies.

While stigmergy is in some sense inheritance of characters through **environment**, it is also clear that there must be a previous state of **coadaptation** between the environment and the individual members or group of members of a species. This is needed in order to trigger the

activity of the individuals. Such activity could lead in some cases to changes in the environment and, eventually, new adaptations in the species.

The monkeys which learned in Japan to clean their tubers in salt water of the seaside, are possibly on their way to stigmergy through shared **behavior**

A process very similar to stigmergy has been described by D. SHÖN (1983, 1987) and J. BAMBERGER and D. SCHÖN (1991) and named by them "**learning as reflective conversation with materials**". In a note to J. Bamberger, D. Schön used the expressions "reference **entity**" and "reference **structure**" and wrote: "a reference entity is situational...and takes something perceived and bounded in that **situation** as entity for use as comparison, projective **model**, prototype within that situation" (J. Bamberger, 2000, p. 15)

He adds however that "it cannot travel from situation to situation" (ibid). Thus an agent-supposedly a living agent- is a necessary go-between.

3199

STIGMERGY (Selective) ²⁾⁴⁾

The progressively limited **selection** among environmental **clues** tending to the most efficient **behavior**.

An example is the finding of food by ants. When different **paths** are possible "the first ants to arrive at a fork choose their way at **random**. They leave **pheromone** trails behind them and newly arriving ants will choose the most "pungent" path, which tends to be the shortest. Longer paths disappear as the pheromone evaporates" (M. WARD, 1998, p.34)

This **reinforcement** based on **selection** through **positive feedback** is obviously a very general **process** that better explains the origins of stigmergy itself. It can be observed in many social **situations** in animal and human societies.

3200

STILL-PICTURE MODEL ²⁾

The model of a system at a given moment.

This expression was proposed by B. BANATHY (1973, p.88).

It is quite useful since this 'snapshot' view is by nature repetitive and helps to visualize the continuously changing character of the system.

Of course, it also helps to understand that such a still-life and **static image** of the system is, if not repetitive, very misleading.

3201

STIMULATION (THRESHOLD of)

→ **Threshold of Stimulation**

3202

STIMULUS ¹⁾

1. "Any physical **energy**... that (a) actually (not potentially) participates in the excitation (or activation) of sensory **receptors**, and, (b) is independent of any activity which the **subject** may engage in" (S. KATZ, 1976, p.42).

2. "Anything that touches off a **receptor** or causes a **response**" (J.J. GIBSON, 1986, p.56).

St. KATZ comments: "... the term **stimulus** is identical to what POWERS calls a **disturbance**" (ibid).

However, the *perceived* stimulus is not anymore only an **event** in the **environment**: it is received and treated in a definite way by an **autopoietic system**.

As to GIBSON, he states "And note above all that an **object** cannot be a stimulus, although current thinking carelessly takes for granted that it is one" (ibid). A **response** is then an **effect** in a perceiving **organism**, i.e. *one that is organized to perceive it*. Observe also that **perception** is not necessarily conscious: a living **organism** perceives ultraviolet light, but is not conscious of it.

Any **organism** need a proper level of stimulation. Insufficient stimuli, as well of excess of them would send the organism out of its limits of **dynamic stability** and could destroy it.

3203

STIMULUS (Discriminative) ²⁾

This notion introduced by W.T. POWERS (his page on the web) seems to imply two different meanings:

1) the stimulus reflects a former behavioral **reinforcement** relative to what it is significant. In turn, it triggers one more reinforcement **event**. For a driver an example would be: "On this corner I must turn right to reach my home" and later on "In effect, after having turned right, I am now reaching my home".

2) the stimulus reflects a number of significant characteristics that help to recognize the corner, as for ex. a one-way traffic sign, a restaurant and a lighting post with the number 23.

The discriminative stimulus is thus related to POWERS' **environment function**.

3204

STIMULUS within CONTEXT ^{1) - 3)}

According to G. BATESON, no stimulus can be significant out of **context**. He correspondingly proposes: "a **hierarchy** of logical types as follows:

- Stimulus is an elementary **signal**, internal or external.
- Context of stimulus is a **metamessage** which classifies the elementary **signal**.
- **Context of context** of stimulus is a **metamessage** which classifies the **metamessage**. And so on" (1973, p.260).

In this case, the concept of **metasystem** is of great significance (J.van GIGCH).

3205

STIMULUS-RESPONSE ²⁾

"A mechanistic **model** involving causal chains." (T.F.H. ALLEN & T.B. STARR, 1982, p.278).

It would possibly be better to write "involving only a single linear causal chain".

3206

STOCHASTIC EFFECTS ^{1) - 2)}

The possible effects that can be produced by **random perturbations** in a system.

These effects can be either insignificant, or very serious, as explained by P.M. ALLEN et al: "Instead of stochastic effects being simply minor irritations for the **modeller**, producing a deviation from the "mean" of his **predictions**, we see that in fact they (may) drive the system from one **state of organization** to another - they are the vital force of **evolutionary change**" (1984, p.248).

The "vital force" of **change** seems in fact to be **energy overload**, while in the **far-from-equilibrium situations** thus produced, a stochastic **event** can act as an **trigger** orienting the **change**.

→ **Nucleation**

3207

STOCHASTIC PROCESS ²⁾

A process that runs through successive **random**, or seemingly **random (chaotic) states**.

Stochastic is, basically, that which cannot be forecasted in a strictly **deterministic** mono-causal way. Examples are epidemics, traffic on crowded roads, stock market **fluctuations**, movements in crowds.

It is "none the less possible to specify both the average (random) interval and the ultimate **pattern** to which those intervals will tend to conform in the long run" (S. BEER, 1967, p.43).

F. HEYLIGHEN states however that, in stochastic processes (e.g. **MARKOV chains**) "... a given **initial state** may have several outcomes with different probabilities" (1990a, p.432)

3208

STOCHASTIC RESONANCE ²⁾

The **amplification** of a specific **signal** through a **random noise**.

This **phenomenon** has been described by the Italian physicists R. BENZI, A. SUTERA and A. VULPIANI (see K.S. BROWN, 1996, p.28-31).

In some cases, the very small impact of the **random noise** on the **signal** that may become significant as a **trigger** for a specific **process**, is sufficient to push the **signal** over the brink of **effectiveness**. This **model** has been used by the Italian physicists as a possible explanation for the periodic ushering of ice ages. Other examples are also known. A similar **effect** could explain the sudden magnification from quite

small transactions in the stock market into a generalized panic. In all these cases, of course, the affected system must be close to some **instability threshold**. Still another hypothetical possible case would be a massive change in the oceanic waters circulation **patterns**, for example as a result of partial desalinization of superficial waters by a massive flow of non-salted water due to partial or total deglaciation of the poles.

As stated by R. VALLÉE, **noise** can be an excellent **structure** displayer, even at macroscopic level (1990, p.55).

Stochastic resonance could conceivably be used to produce some **trigger effects**, or explain some whose direct cause is not clear. For more, see P. Mc CLINTOCK and D. E. LUCHINSKY (1999, p.37-39)

→ **Order from noise**

3209

STORAGE¹⁾

The **process** by which the system accumulates **reserves** of **matter**, **energy** and/or **information** and becomes able to delay and select its **responses** to **stimuli**.

P. VENDRYES explained the importance of storing **reserves** for the **operation** and the **maintenance** of **dynamic stability** in systems in general (1942).

He took his insight from the example of physiological **reserves** of the living being, as for example glycogen or fats, which allow for the intervention of functional **regulations** and the **maintenance** of biological **functions** within satisfying **limits** of **oscillations**, in front of the variations of the **flows** incoming from the **environment**.

It is, in fact, that capacity to store **reserves** which allows **organisms** to acquire their **autonomy** in relation to this **environment**, to organize their own internal milieu (or "**environment**") and to maintain what Claude BERNARD named "the constants of the internal milieu", also studied later on (1932) by Walter CANNON under the name of **homeostasis** (1963).

The fundamental potentiality of the stored **reserves** is that they are counter-**random**.

VENDRYES extended in his last works these views to historical, social and economic (including firms) systems (1981).

No system could do for long without such **reserves**, which are needed to counteract **perturbations** from the **environment**.

However, the storage **process** is not free. Stores are **structures** that must be constructed and maintained. For example, H.T. ODUM writes, referring himself to the storage of **energy**: "... such work requires a dispersal of some potential **energy** into heat... If the storing is done at the maximum possible **rate**, then 50 percent must be delivered into the heat **sink**" (1971, p.38-39).

3210

STORAGE CAPACITY^{1) - 2)}

Different types of systems have different storage capacities. According to H.T. ODUM, storage capacity depends in biological and ecological systems of "...the volume to surface ratio, which varies according to the **size** of the storage unit, being large in elephants and small in bacteria" (1971, p.256).

Furthermore, storage becomes more differentiated with **complexity**. **Social systems** have thus an extreme **variety** of storage devices, which correspond to the necessity of disposing at any moment of sufficient counteraleatory **reserves**.

3211

STORAGE (Matter-Energy)^{1) - 2)}

"The **subsystem** which places **matter** or **energy** at some **location** in the system, retains it over **time**, and retrieves it".

This is one of the 20 **critical subsystems** in J.G. MILLER's **taxonomy** of **living systems** (1978, p.3). Obviously this term is a generic one which covers a **variety** of different specialized storage **subsystems**.

3212

STORE¹⁾

1. A supply of some **resource** put in stock somewhere in a system for future use.
2. A specific **subsystem** where such a **resource** is stocked.

The existence of unused **resources** is a guarantee of **survival** for the system if it should be cut off from some necessary **inputs**.

For P. VENDRYES, the existence of such **reserves** is an absolute condition for the **autonomy** of the system (1942, 1981).

3213

STORY TELLING^{1) - 3)}

The use of stories to emphasize some critical and sometimes unheeded aspect of a **situation**, especially in **complex systems**.

This technique has been widely used by R. L. ACKOFF, and sometimes produces striking results. Stories help to discover original angles and new **meanings**, get out of the rut by avoiding commonplace views and stuffy overbearing prejudices, produce **synergies**, increase **competence** in participants and generally stimulate creative insights.

According to R. SCHANK, storytelling is also and **endogenous mnemonic process** of **stabilization** of recollections: "It is the **process** itself of creation of the story which creates the mnemonic **structure** that will contain the basics of this story for the rest of our life" (1995, p.154).

In both cases, the story can be a fabrication, but it is then a meaningful one. A related subject is the construction of **scenarios** for **forecasting** and **planning purposes**.

R. NUMMELA CAINE and M. CAINE observe: "Stories are powerful because they bind **information** and **understanding** over **time**. In fact, there is strong reason to believe that **organization of information** in story form is a natural **brain process**... At a minimum, a story is a sequence of experiences with a meaningful theme" (1994, p.121-2)

Indeed, story telling is as old as Gilgamesh, Ramayana, or Ulysses epopeas and the Bible itself: **values**, **norms** and **understanding** transmitted through an easily assimilated mental fare.

In a somewhat different sense, story telling is unavoidable, even as a contribution to scientific **knowledge**.

C. SLUZKI speaks of the "**EIGEN-values** of stories" (1995, p. 41) Of course, even if very imaginative or even fanciful, no story can make any sense if not connected to what SLUZKI call a "system of **narratives**". Moreover, different **cultures** can offer widely different systems of narratives, each within its own "whole conversing system" (id. p. 45)

S.J. GOULD observes (in "Wonderful Life", as quoted by P. BAK (1996, p.7): "Many large **domains** of nature - cosmology, geology and **evolution** among them - must be studied with the tools of **history**. The appropriate **methods** focus on narrative, not experiment as usually conceived".

This is so because, in these **domains**, no **event** is ever exactly repeated and no reproducible **experiment** can be organized that could eliminate all **contingencies**.

Of course, the **analogies** discovered among different, but more or less similar **events**, as for example a number of earthquakes or various hurricanes, can produce a deeper **understanding** of a whole **class** of **phenomena** and decrease the arbitrary perceptive deformations and interpretations always possible in story telling.

A good example is the discovery of the so-called laws of **chaos**, initially derived from meteorology research by E. LORENZ.

3214

STRAIN^{1) - 4)}

The **state** of a system submitted to **stress**.

Strain can be sustained merely up to some specific **limits**. For instance, **stress** applied by stretching a metal bar, may, according to the force applied:

- when slight, have no visible effects;
- when stronger, induce a permanent deformation;
- when very strong, make it suddenly snap. ("The last straw that broke the camel's back").

Analogically, **living systems** and **organizations**, when submitted to **stress** and suffering strain, may react in the same ways.

It could be said that **constraints** are permanent strains to which a specific system has adapted permanently.

3215

STRATEGIC PLANNING IN ORGANIZATIONS⁴⁾⁵⁾

R. ACKOFF writes: "Strategic planning (selection of ends) tends to flow from the **topdown**, and tactical planning (selection of means) tends to flow from the **bottom up**"

"...it seems to me that strategy can be characterized, if not defined, as follows:

"1. An organization's strategy consists of those **decisions** that are made by its highest **level of management** and that affect the organization as a **whole**

"...**decisions** not made at the top or that do not affect the whole organization are tactical. It follows, then, that a decision that is strategic from an organizational **component's** point of view will be tactical from the organization's point of view. Therefore "strategy" and "tactics" are relative concepts depending on the organizational **level** at which the defining is done.

"2. Strategic decisions set **objectives** for the organization as a whole, relatively long-range objectives, and formulate policies and principles intended to govern **selection** of means by which the **objectives** specified are to be pursued and...

"The focus of tactical decisions is **efficiency**"...while "the focus of strategic decisions is **growth**" (1990, p. 523)

It seems that also in some cases the fight for **long term** (and even **short-term**!) **survival** is a matter of strategy

"3. Strategic decisions focus on prior (**anticipatory**) and posterior (after-the-fact) responses to such potential and actual **changes** in an organization's **environment** as can affect its **performance** significantly and...

"Finally, I think it essential that strategic decisions be so formulated that their implementation and expected **effects** can be monitored

"This requires that their expected effects be stated in observable terms and that they be accompanied by a specification of the times by which the effects are expected" (p.524)

3216

STRATEGY¹⁾

"A preprogrammed behavioral policy" (R. DAWKINS, 1978, p.74).

Such a **program** normally covers **long term planning**.

Tactics are, or should be, subservient to strategy.

According to R. ACKOFF, who reproduces an older definition by himself (1974): "**Strategy** is concerned with long-range **objectives** and ways of pursuing them that affect the system as a **whole**, **tactics** are concerned with shorter-run **goals** and **means** to reaching them that generally affect only a part of the **organization**" (1990, p.523)

While "the focus of tactical **decisions** is **efficiency** the focus of strategic **decisions** is **growth**".

Strategic **decisions** are at times still more fundamental, as they may have to see with the very **survival** of the **organization**.

ACKOFF further distinguishes normative **decisions** "which have an infinite perspective because they focus on ideals, ends that can never be obtained but that can be approached without **limit**. The focus of normative **decisions** is **effectiveness** (which, in contrast to **efficiency**, is a **value-loaded concept**) and **development** (which in contrast to **growth**, has nothing to do with **size** or number, but with an increase in one's ability and desire to satisfy one's own **needs** and desires and those of others" (Ibid).

E. MORIN observes that any strategy should include the consciousness of **uncertainty** in general (1999a, p. 66). Any strategy operates through a program: "The **program** is efficient within stable external conditions, that can be established in a secure manner. However the least **perturbation** of these conditions destabilizes the program's execution and tends to block it" (p. 66)

Finally, we must always navigate in "an ocean of **uncertainty** with some archipels of certainty" (1999b, p. 17)

If there is no **awareness** of any uncertainty, then the strategy and the program are mere bets based on unsustained beliefs and can easily lead to disaster.

Of course, strategy is the activity of a strategist, i.e. a leader who, in a more or less hierarchical and even autocratic way, decides about the future course of the system.

In a sense, this reflects a deeply ingrained **deterministic model** and is antagonistic to the concept of **self-organized behavior** for the system.

The possibility to reconcile both **models** and how eventually to do it, remain two open questions.

Strategies should also care for global **transformations**, with special care for the proper and permanent harmonization of the various **processes** and **functions**, in order to guarantee not only **long-term efficiency**, but also **resilience** and **survival conditions**.

These aspects must be paramount in the definition of pursued **goals**. Most man-made **messes** result from ignoring such traps.

3217

STRATEGY and TACTICS¹⁾

The American Heritage Dictionary defines tactics as: "The technique or science of securing the **objectives** defined by strategy".

Strategy covers **long-term planning** and thus embeds tactics. Furthermore, various tactics are generally possible in order to reach strategic **objectives**.

From a most embracing viewpoint strategy, as well as tactics, depends on the best possible **knowledge** of the considered system, which introduces at least two different, but related, problems:

- the evolving global conditions of the system are rarely known with a sufficient precision, which leaves many times strategy in doubt, or conditional to a subsequent betterment of our **knowledge**.
- In complex systems, **chaotic transformations** reflect this insufficient **knowledge** and may introduce difficulties even at the tactical **level**.

However the general **embedment** of **short-term trends** within **long-term** ones may be of some help.

3218

STRATEGY (Evolutionarily stable)^{1) - 2)}

A strategy which, if most members of a **population** adopt it, cannot be bettered by an alternative strategy" (R. DAWKINS, 1978, p.74)

According to DAWKINS, this concept was introduced by J. MAYNARD SMITH.

DAWKINS explains it as follows: "... the best strategy for an individual depends on what the majority of the **population** are doing. Since the rest of the **population** consists of individuals, each one trying to maximize his *own* success, the only strategy that persists will be one which, once evolved, cannot be bettered by any deviant individual" (Ibid).

This is totally valid only in stable **situations**, as recognized by DAWKINS: "Following a major **environmental change** there may be a brief period of evolutionary **instability**, perhaps even **oscillation** in the **population**" (Ibid).

It should be observed that to speak of the evolutionary strategy of a **population** is somewhat semantically abusive. The individuals are more or less collectively subservient each one to all the others, in a statistical way: the global so-called strategy cannot be assigned to any specific entity; it remains diffuse within the **population**, and may be represented by a **transitions probability matrix**.

3219

STRATUM²⁾

"The **level of description** or **abstraction**" (M. MESAROVIC's et al **taxonomy of types of hierarchical levels**, 1970, p.37)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

A stratum is a horizontal **layer** in a **hierarchy**.

3220

STRESS ¹⁾ - 4) - 5)

1. An internal tension induced in a system by unfavorable external factors, impacts of **situations**.

Materials can be stressed, for example by excessive weight, compression, pulling or stretching. The result is **strain**, and sometimes **breakdown**.

The concept has been extended to physiology (see hereafter), and in a somewhat metaphorical way, to psychology and social psychology.

2. The **state** corresponding to all non-specific **responses** of the body to any demand.

(This definition is a synthesis of various more or less equivalent ones given by H. SELYE, who introduced the concept) (1975).

"Any demand" is practically anything that affects the system's **homeostasis**, which means quite normal activities as well as aggressions coming either from the **environment** or from the **invironment**.

SELYE states some interesting points:

"- The stress **response** is, by definition, not specific, since it can be produced by virtually any **agent**.

"- The stress is not a non-specific reaction: The **pattern** of the stress reaction... affects certain **organs** in a highly selective manner.

"- Stress is not necessarily something bad... The stress of exhilarating, creative, successful work is beneficial, while that of failure, humiliation, infection is detrimental.

"- Stress cannot and should not be avoided" (Ibid, p.63)

The concept of stress is closely related to the **General adaptation syndrome** concept, also introduced by SELYE.

While it is originally biological, it could quite probably be usefully generalized to psychology (HORVATH, 1959), to the social sciences (M. Mc LUHAN) and to any type of systems in general.

According to M. TIMSIT-BERTHIER (see Ph. LAMBERT, 1998), the mental component of stress - which probably never appears in animals, because their **behavior** is mainly organized at the limbic **level** of their **brain** - becomes very important and probably dominant in the human species.

"Stress traduces any **semantic** or psychological **reaction** of an individual who feels that what is demanded from him exceeds his/her possibilities of **response**" (p.331)

It is of course difficult in most cases to differentiate both aspects: "Is the marathon runner becoming physically stressed when the **rhythm** of the race becomes unsustainable for him, or mentally when he is not anymore able to maintain himself on par with his competitors?"

In practical contemporary life, negative future expectations - whether imaginary or more or less founded (fear of losing one's job for ex.) - which are mental and psychological, seem to make psychological stress as the initial stage of the **process**, which becomes basically psychosomatic.

This seems closely connected with the development of **time perception** in man. "It is now known that it is not so much the intensity of the hormonal secretions than their disorganization in the temporal dimension that leads to pathological **effects**" (p.339)

G. BATESON made the curious comment that "... stress is a lack of **entropy**, a condition arising when the external **environment** or internal sickness makes excessive or contradictory demands on an **organism's** ability to adjust (1979, p.230).

Would this not be better expressed as "a lack of capacity to produce **entropy**". BATESON himself adds indeed: "The organism lacks and needs **flexibility** having used up its available commitments alternatives" (Ibid).

3221

STRESSOR ²⁾

"That which produces stress" (H. SELYE, 1975, p.78).

Or, according to O.R. YOUNG: "... any externally or internally generated force or **process** which threatens a system's **stability** in one or more respects" (1964, p.80).

Stressors may be external or internal, momentaneous or permanent. They are sometimes easily identified, but in some other cases they can be quite hidden.

3222

STRUCTURAL ANALYSIS ²⁾

R. ROSEN states: "The entire **process**... beginning with the isolation of atomic **subsystems**, their recombination to generate a large class of systems, and the **rules** for selection a subclass of system of interest out of these, are implicit in the notion of '**structuralism**' or structural analysis for the study of **complex systems**. We have amply seen that the word '**structure**' has to be interpreted in a very wide sense; indeed in biology the relevant '**structures**' are always defined in functional terms" (1972, p. 63).

This is not only true in biology: any **functional process** that can be observed corresponds to a **structure** and, furthermore many observed **structures** are only the visible appearance of a **long or very long term** ongoing **process**.

3223

STRUCTURAL CLASS ²⁾

"A set of two or more **objects** (X) or **environments** (X-) that have one or more structural properties in common" (R.L. ACKOFF & F.E. EMERY, 1972, p.18).

ACKOFF and EMERY state: "Thus **structure** is a general concept applicable to geometric, kinematic and mechanical properties, and to any properties that can be expressed as **functions** of them" (Ibid).

In other words it is a powerful source of **isomorphies**.

3224

STRUCTURAL COUPLING ²⁾ - 5)

Reciprocal structural modifications in two **autopoietic systems**, whose **interactions** are **recursive** or very **stable** and which disturb each other (W. KARGL, 1991, p.585).

This concept corresponds to systemic **familial therapy**, but could have applications in the case of economic or **social systems**, and even possibly in physics (binary stars systems).

→ **Coupling (Structural)**

3225

STRUCTURAL DIFFERENTIAL ²⁾

A diagram that can be used to clarify the **semantic** aspects of an **observer's relations** with "reality".

The Structural Differential was introduced in 1933 by the Polish-American linguist and psychologist A. KORZYBSKI (1950a, p.387). His point was to induce a clear **perception** of the differences between outside reality, **perception**, **description** and labelling. He writes (observe his use of quote marks, which mean in every case "that something that we call..."):

"If we take something, let us say the **object**... called "pencil", and enquire what it represents, according to science 1933, we find that the "scientific **object**" represents an "**event**", a mad dance of "electrons", which is different every instant, which never repeats itself, which is known to consist of extremely complex **dynamic processes** of very fine **structure**, acted upon by, and reacting upon, the rest of the universe, inextricably connected with everything else and dependent on everything else. If we inquire *how many characteristics*... we should ascribe to such an **event**, the only possible answer is that we should ascribe to an **event** infinite numbers of characteristics, as it represents a **process** which never stops in one form or another; neither, to the best of our **knowledge**, does it repeat itself.

"In our diagram... we indicate this by a parabola A, which is supposed to extend indefinitely, which extension we indicate by a broken off line B. We symbolize the characteristics by small circles C, the number of which is obviously indefinitely great.

"Underneath, we symbolize the **"object"** by the circle O, which has a finite size. The characteristics of the **object** we also denote by similar little circles C'. The number of characteristics which an **object** has is large, but *finite*, and is denoted by the finite number of the small circles C'.

"Then we attach a **label** to the **object**, its name, let us say "pencil", which we indicate in our diagram by the **label** L. We ascribe also characteristics to the **label** and we indicate these characteristics by the little circles C'.

"The number of characteristics which we ascribe by *definition* to the **label** is still smaller than the number of characteristics the **object** has. To the label "pencil" we would ascribe, perhaps its length, tickness, shape, colour, hardness. But we would mostly *disregard* the accidental characteristics, such as a scratch on its surface, or the kind of glue by which the two wooden parts of the objective "pencil" are held together. If we want an objective "pencil" and come to a shop to purchase one, we say so and specify verbally only these characteristics

which are of particular *immediate interest* to us...

"If we inquire as to the neurological **processes** involved in registering the **object**, we find that the nervous system has *abstracted*, from the infinite numbers of sub-microscopic characteristics of the **event**, a large but finite number of macroscopic characteristics...

"But this is not all. The **object** represents in this **language** a gross macroscopic **abstraction**, for our nervous system is not adapted for abstracting directly the infinite number of characteristics which the endlessly complex dynamic **structure** of the **event** represents. We must consider the **object** as a *first abstraction* (with a finite number of characteristics).

...
"The **label**, the *importance* of which lies in its *meanings* to us, represents a still higher **abstraction** from the **event**, and usually **labels**, also, a **semantic reaction**" (1950, p.387-9).

It is impossible to do justice to KORZYBSKI fundamental work through a short quotation.

He also uses the structural differential to clarify the **relations** between different **labels** of the same **"object"** and the successively more abstract **labels** that can be attached for different **purposes**, to an **event** as for example: "Max", "German shepherd", "dog", "mammal", "vertebrate", "animal", "living being", "life".

The content of his work constitutes a complete course in mental sanitation and he must be considered one of the most important pioneers of Systemics.

3226

STRUCTURAL MODELING

→ Interpretive structural modeling

3227

STRUCTURAL SATURATION ²⁾⁴⁾

The critical **threshold** beyond which more structure building becomes redundant.

Such **thresholds** seem to result from **interactions mechanisms**, either automatic as for example in termites building their nest under the influence of emitted and perceived **pheromones**, or through the direct **perception** of some **redundancy level**, as in human social **behavior**. (Overburdening bureaucracy for instance)

M. MARUYAMA, in an off-hand comment, once observed that two post-offices are never built close to each other, because such a **redundancy** would be very inefficient.

3228

STRUCTURALISM ^{1) - 3) - 4)}

R.M. SNOW considers structuralism "as the continental variant of systems thinking" (1993, p.138).

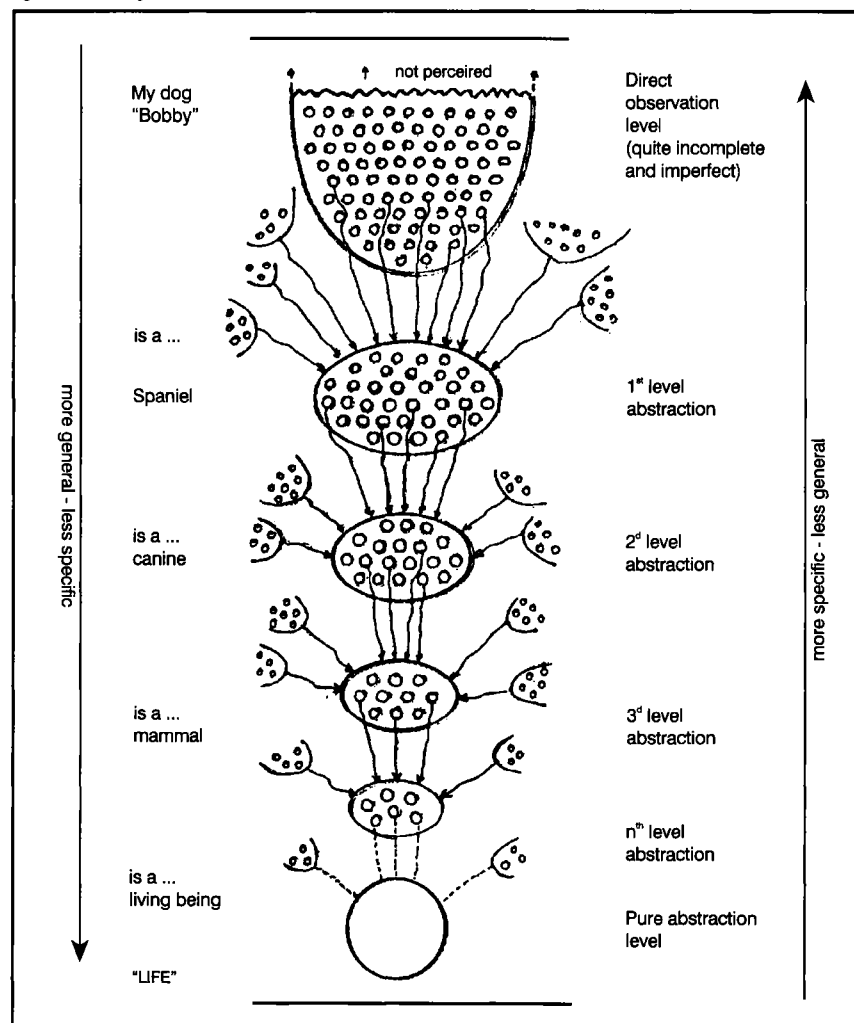
This seems a somewhat excessive view. Systems thinking has many roots, even in Europe. The **Gestalt** movement (KOHLER, KOFFKA), for instance, is no less important than linguistic structuralism (SAUSSURE, JAKOBSON) or psychological or anthropological structuralism (PIAGET, LEVI-STRAUSS).

It is however true that: "Structuralists emphasize the systems **elements** and their **interrelationships**, and how these are transformed in surface/conscious structure. Structure and any **change** therein are considered sufficient means for exploring both individual and collective **behavior**. The question of **function** or **purpose** is rarely addressed. When it is considered, systemic **action** toward a **goal** is viewed as constrained or determined by the structure which produces it" (Ibid., p.139).

This statement makes clear that structuralism does not merely implies a **synchronic** viewpoint, but altogether a **diachronic** one.

This point is however not obvious for everybody (not even for some structuralists themselves). As noted by H. SABELLI: "**Structure** is opposed to **change** and appearances..."

Figure: see entry STRUCTURAL DIFFERENTIAL



KORZYBSKI's Structural differential used for modelling the Abstraction process
Ch. FRANÇOIS

"This implies a danger to dismiss what is evident as mere **emergence**, overvaluing speculations and rationalizations. Structuralism leads us to overvalue **similarities** at the cost of **differences** and **stability** at the cost of **change**" (pers. comm., 1994).

M.C. JACKSON retains a practical orientation in structuralism, which: "... in the realist form, is concerned with uncovering and **understanding** the underlying **structures** or systems of **relationships** that generate the surface **phenomena** perceived in the world. It demands explanation of the **phenomena** available to our senses in terms of the underlying, unobservable **mechanisms** that generate them. Structuralists attempt to provide **models** of the causal **processes** at work at the deep structural level..." (1992, p.23).

"A movement in social science, originated by Cl. LEVI-STRAUSS, which supposes that social **structures** depend on certain basic characteristics of human **brain programs**, giving specially attention to **binary** operations that are used in **communication**" (J.Z. YOUNG, 1978, p.299).

YOUNG adds: "Structuralism" is also sometimes used to define the type of **linguistics** that studies surface structures rather than CHOMSKY's more abstract deep structure" (Ibid.)

3229

STRUCTURALISM and HISTORICISM¹⁾ - 3)

BLAUBERG, SADOVSKY and YUDIN point out: "In the literature on the question, structuralism is not infrequently presented as antithetic to historicism. It is stated that any structural research rejects the historical approach in principle" (1977, p.31). The authors do not accept this viewpoint.

This observation is concurrent to others by different authors and corresponds to a tendency to formalism noted in the works of some structuralists (in linguistics and cultural anthropology for example).

On the other hand an a-historical stand is only part of a non-dynamical one and serves as a basis for an artificial opposition between structure and function.

Obviously, however structure is a historic remainder or **memory** of a probably more or less **cyclic process** and it can persist on a **long term** basis in the future only if the **process** remains functional.

Furthermore, **behavior** is incited by **structures**, which are traces of older **behavior** (cf. the concept of **stigmergy**).

3230

STRUCTURE¹⁾ - 2)

The **set** of the stable **interrelations** between the **elements** or **components** of an entity (or system).

M. BUNGE extends structure to the **relations** among the **components** of the system and the **environment** (1979, p.4).

Many different definitions have been enounced by numerous authors, as for example:

"The arrangement of the **subsystems** and **components** in three-dimensional **space** at a given moment of **time**" (J. MILLER, 1978, p.22).

The Argentinian biologist M. CEREJIDO proposes a very similar definition, but makes the following comment: "The instantaneous disposition is frequently called **configuration**", while "structure" would be the durable disposition, i.e. what successive dispositions have in common" (1978, p.29).

According to FEIBLEMAN & FRIEND "Structure is the sharing of **subparts** between **parts**" (1945 - 1969, p.48).

They complete this definition in the following significant way: "In every **action**, there is a sharing and an **interchange**".

Thereafter they comment: "The sharing which constitutes the structure is from the point of view of the **whole** represented by the sharing which constitutes the **function**".

This was formulated in a striking way by E. JANTSCH, in terms of "Spatial self-balancing of a system of **processes**. Their **interaction** generates structures which may be compared to standing-wave **patterns** rather than solid constructs" (1975, p.27). See for example: "**Soliton**".

In the same vein, K. KRIPPENDORFF states: "Any **communication process**, once initiated and maintained, leads to the genesis of social structure, whether or not such structure is anticipated or deemed desirable" (1971, p.171). This is a very interesting insight in relation to various systemic concepts: **morphogenesis**, **sybiosis**, **parasitism**...

G. KLAUS definition is still less static: "Set of the material relations existing between active **elements** in a dynamical system" (1976, p.79).

In other words, it is impossible to leave aside the concept of **time**, even in such an apparently static notion as structure. In BLAUBERG, SADOVSKY and YUDIN's words: "The point is that a complete **abstraction** from any time is only possible in a strictly limited class of problems dealing with the investigation of the anatomy or the **morphology** of the **object**, when analysis of its *purely synchronic* cross-section becomes both possible and necessary.

"Knowing the composition of the **object**, its anatomy and **morphology** does not imply however, **knowledge** of its **structure**. Structure is not dead cast of the **frozen object**, but a characteristic of those of its invariant aspects which are only revealed during the analysis of its actual **dynamics**" (1977, p.236).

A good example is petrified wood, in which the relative **relations** among **parts** have been conserved, while the *nature* of the **parts** themselves has changed: complex chemical reactions have replaced wood by stone, in the course of eons.

However, while being not only **synchronic**, but altogether **diachronic**, structures are repetitive in a **cyclic**, **hypercyclic** or **cyclomorphic** way, within the **autopoietic** frame of **organizational closure**.

This point is clearly made by W.R. ASHBY, who writes: "... the structure of **"machines"** appears when the **laws** that govern the system are invariant in **time**" (1964, p.93). Or, in other words: no structures without permanent **constraints**.

Differently, **evolution** signals itself by innovative **events**.

In R. FIVAZ the global structure of a system is: "described by one or several **order parameters**" (1991, p.32).

This connects the concept of structure with **synergetics**.

Structures can be represented by **graphs**, some types more easily than others, as for example **linear** chained structures, circular, or **cyclical** structures, or centered structures, described by B. WALLISER (1977, p.52). When oriented, **graphs** give some idea of the **dynamics** of the structure, as for example in the basic **schemas** of **systems dynamics**. As observed by J.van GIGCH, structures are frequently **hierarchic** (1978, p.15). However, in **networks** for example, this is not necessarily so.

3231

STRUCTURE and EVOLUTION¹⁾

Structure, under its **diachronic** guise, is the **repertory** of those **transformations** acceptable for the system (i.e. corresponding to its **variety** content in ASHBY's sense).

Strictly speaking it would be better to say that systems do not *evolve*, but undergo **transformations** (allowed by their structure).

However, when "the alteration is so important as to become necessarily irreversible, an historical **process** takes place, giving birth to a new structure" (J.L.LE MOIGNE, after J.G. MILLER).

C. BRESCH in his comprehensive study of evolution (1977) observed that structure tends to be structuring, i.e. to generate **complementary** or countervailing structures.

He also explained that structures develop out of **components**, but within the **limits** of pre-existing **constraints**.

→ **Auto-genetic systems precursors; Co-evolution; Structure (Conservative); Structure genesis (Law of); Zero-system**

3232

STRUCTURE and PROCESS^{1) - 2)}

Structure and process (and also **function**) are intimately related. E. JANTSCH writes: "In a **nonequilibrium** world of self-realizing, self-balancing systems, process and structure become complementary aspects of the same overall order of process, or *evolution*. As interacting process define temporary structures – comparable to standing-wave **patterns** in physics – so structures define new processes, which in turn give rise to new temporary structures. Where process carries the momentum of **energy** **unfoldment**, structure permits the focusing and acting out of **energy**" (1976, p.39).

See for ex.: "**Soliton**".

Generally, **evolution** seems to be a result of **dissipative structuration** in far-from-equilibrium systems, which allows for upgrading of **organization** through an increased **energy** consumption and **entropy** production.

3233

STRUCTURE (Conservative)²⁾

A structure which is constantly reproduced.

Conservative structures are a basic feature of **autopoiesis**. They are transmitted through **self-referential processes** and specific **channels** such as DNA, **neural nets**, or cultural **values**.

The process of **reproduction** of conservative structures is akin to the **stigmergy process**.

3234

STRUCTURE (Deep)²⁾

Some systems are able to resist complete dissolution when submitted to violent **turbulence** and may restructure themselves at a higher level of **complexity**. In such cases, they do not lose completely their former structure, of which the subsisting part has been called "deep structure" by E. JANTSCH.

Ch. SMITH resumes as follows this concept: "This deep structure, as explained by JANTSCH, might be locked at as the evolutionary **state** of the system, the degree of sophistication or elaboration that the system has attained and that is irreversible even in the face of forces of dissolution. The deep structure thus serves as a **self-referencing framework** for experimenting **behavior**, pruning **choices** and guiding movement toward new structures. The structures adopted will be consonant with the system's accumulated evolutionary **learning**, its previously developed capacity to maintain **viability** amidst the **complexity** of its **environment**" (1986, p.206).

Somehow a really deep evolutionary **transformation** of the system implies the destruction of the superstructures, but not of the basic core of **organization** in its most general features.

The concept of deep structure seems relevant for example, to chrysalides, at biological **level** and probably to basic mutations as in GOULD and ELDREDGE's punctuated **evolution**. Important cultural mutations possibly follow the same **pattern**: e.g. the **survival** of Greek and Roman cultural structures in Christian cultures.

→ **Radiation (Self-contained)**

3235

STRUCTURE (Dissipative)^{1) - 2) - 4)}

"... the ordered **configuration** that emerge beyond **instability** of the **thermodynamic** branch".

This G. NICOLIS and I. PRIGOGINE (1978, p.60) definition comes as a conclusion to their introductory chapter on **nonlinear thermodynamics**.

I. PRIGOGINE described dissipative structures as "... in **far- from- equilibrium** conditions, **states of matter** characterized by coherent **space-time behavior**" (1973, p.565). He also wrote: "... dissipative structures... are formed and maintained through the exchange of **energy** and **matter** in **non-equilibrium** conditions". He associates this with "creation of **order**" (p.581). However, in the very **process** of dissipative structuration, a **stochastic event** normally acts as a **trigger** (1976, p.93).

PRIGOGINE makes another very significant statement: "... the dimensions of the system play an essential role in the formation of dissipative structures. A sufficiently small system will always be dominated by the **boundary conditions** (NAZAREA, 1974). In order for the **nonlinearities** to be able to lead to a **choice** between various solutions, it is necessary to go beyond some **critical spatial dimensions** (HANSON, 1974). It is only then that the system acquires some **autonomy** with respect to the outside world" (p.101).

E.J. KROWITZ explicits the **concept** in the following way (after BAHG Chang Gen, 1990): "Three conditions identify a dissipative structure:

- The system is **open** with continual interchange with its **environment**;
- The system is in a **state** of damped **instability**;
- The evolutionary **path** of the system stems from **fluctuations** which push the dynamic structure from one **state** to another" (1991, p.47).

Dissipative structures were first observed in the opening years of 20th. Century by the French physicist H. BÉNARD, who observed the progressive **emergence** of **hexagonal** convective cells, replacing simple thermal agitation, in a heated liquid, once a critical temperature **gradient** is reached, i.e. when **thermodynamic equilibrium** is breached.

This corresponds to **symmetry breaking** resulting from a considerable **input of energy**.

Analogous **phenomena** were observed by PRIGOGINE and his groups in a wide variety of physical, chemical, biological, and even later in **social systems**, which receive increasing **inputs of energy** and, as a result, start to develop evergrowing **fluctuations** and react by creating organized (or more organized) **macro-structures**.

Starting from these observations, PRIGOGINE created his generalized **thermodynamics**, applied to all **systems far away from equilibrium**

"The **stability** of dissipative structures is different in kind of **stability** in **steady states**. It is not a result of a low **production of entropy**, but instead, of their ability to transfer to their **environment** great quantities of **entropy**, due to their greater **complexity** (for example under the guise of heat or degraded products). Consequently, when a system organized through dissipative structures does appear, its **environment** tends to become growingly disorganized...

"Dissipative structures result of great imbalances and *maintain themselves* as long as these imbalances subsist. **Processes** which reduce **gradients**, as for example **diffusion**, destroy these structures" (1992).

E. JANTSCH states: "The concept of dissipative structure also implies that the **environment** is necessary to maintain the dissipative structure; unlike **equilibrium structures**, dissipative structures cannot exist independently" (1976, p.40)

It is however very questionable if **equilibrium structures** could do without **environment**. Are they not stabilized former dissipative structures, i.e. having secured the needed permanent **energy inputs**... and even the result of a former stage of **metastability**?

As a result, a system whose **organization** has been upgraded through structuration by dissipation of supplementary **energy**, cannot anymore survive without this supplement.

Through dissipative structures a system is not merely able to absorb more **energy** and **matter**: it reacts to these excess **inputs** and becomes able to use them by reorganizing itself in its own ways. This may be considered as a generalization of the biological concepts of **anabolism**, **metabolism** and **catabolism**, in **morphogenesis** conditions.

The newly emerging structure finally finds its own permanence **limits**, according to the steadiness of the supplementary **inputs** it receives.

PRIGOGINE also states: "A system may undergo various successive **processes** of structuration through crisis. A **bifurcation** of its **evolution** characterizes each of these **processes**" (1992).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

The dissipative structure concept seems to be of utmost importance for the study of the man-planet system presently in course of shaping, specially in relation to:

- the **growth** and acceleration of **flows** through human **organizations**
- the very speedy shaping of new and ever-more complex social structures
- the growing disruption of the global **environment**.

3236

STRUCTURE (Fractal)²⁾

A ramified or subdivided structure, **self-similar** at different **levels**.

Discovered as a mathematical structure by B. MANDELBROT, it is now used to modelize a great number of **self-similar concrete systems** or structures, as for example geographic features as coastlines, or river **basins**; networks ofismic faults; roots and branches of trees; bronchial and lungs structures. H. SABELLI observes that fractal structures, in biological systems, allows for the formation of complex and even irregular structures, starting from a quite simple genetic **template**.

Fractalization in structures also permits an optimum use of available **space**, through miniaturization or micronization.

3237

STRUCTURE (Hierarchic)²⁾

A **multi-level** structure, where some **components, parts** or **subsystems** are subordinated to other ones.

Hierarchic structures appear in **complex systems** with **regulations**. Normally a regulator *manages* or *controls* some functional-structural **subsystem**, or the **relationship** between two or more **subsystems**.

In many cases, different local or specific **regulators** must be controlled or coordinated and a supra-**regulator** becomes necessary. Hierarchic structures thus build up in a progressive way.

Like any structure, they are **diachronic** as well as **synchronic**. Some of them do only become visible in the **time** dimension, due to the widely different **periods** of many **regulations**, and cannot, for this reason, be observed statically.

This is specially of utmost importance for the understanding and management of **human systems**, wherein **long-term** structural effects are many times ignored.

E. JANTSCH states: "Hierarchical **description** of structure usually express the ideal of **equilibrium** both at a given structural **level** and in the relations between **levels**" (1976, p.51).

Hierarchic structures are characteristic of strongly integrated systems, tending to **homeostasis**. Such systems are prone to growing **rigidity** with time.

3238

STRUCTURE (Lacunar)²⁾

In relation to CANTOR's triadic set, M. DUBOIS, P. ATTEEN and P. BERGE explain as follows the nature of fractal dimensions:

"The set thus obtained is formed by rigorously ordered points, even if they seem irregularly distributed. Like all **fractal objects**, this **set** possesses a lacunar structure, which may be expressed by saying that its dimension is not whole, that it is "**fractal**". It is in no way a curve in view that an infinity of segments are not included. Its dimension is contained between 0 and 1 (0.63...) The same type of structure, in a qualitative sense, is to be found in a transversal section (i.e. a **POINCARÉ section** of the **chaotic attractor** constructed by contraction, stretching and folding ad infinitum of a small rectangle in the **phases space**. These **operations** transform a segment inside of the rectangle in the **phases space** into a **set** of points... whose dimension is also less than 1... As to the **attractor** it spreads out... in a complex fashion in a three-dimensional space. Its dimension is contained between 2 and 3." (1987, p.197).

3239

STRUCTURE (Reference)

→ **Stigmergy**

3240

STRUCTURE (Self-facilitating)^{1) - 2) - 3)}

This concept proposed by R.W. FULLER and P. PUTNAM, is interesting because it connects structure and **function**.

The authors explain that, in **networks**, structures tend to be self-reinforcing through the following **mechanism**: **random search processes** in the **network** tend to produce the **emergence** of **relative dominance** of some **patterns** (crf. D. HEBB's **habituation**). This in turn tends to stop the **random search**:

"What stops a **random search** is reinforced again and again – every time the associated **drive factor** is excited – because what satisfies a **drive factor** once will do so again if it catches the basic principle involved" (1967, p.105).

... and: "The historical sequence of **random searches** becomes linked together in a chain" (Ibid., p. 106)

3241

STRUCTURE from ORDER^{1) - 3)}

D. BOHM and F.D. PEAT write: "The concept of **order** is, by itself, of very general interest. But one of its most fundamental and deepest **meaning** is that it lies at the root of structure, which is a key **issue**, not only in science, but in life as a whole. Structure is often treated as being static and more or less complete in itself. But a much deeper question is that of how this structure originates and grows, how it is sustained, and how it finally dissolves. Structure is basically dynamic, and should perhaps better be called *structuring*, while relatively stable products of this **process** are *structures*. But even these latter structures should not be considered as basically static, for they are the results of **processes** which sustain them and keep them, for a **time**, more or less within certain **limits**.

"As with order, so with structure there can be no complete definition. Rather,... whatever we say structure is, it isn't. There is always something more than what we say and something different. At any given stage, it is possible to abstract a certain structure as relevant and appropriate. But later, as the **context** is made broader, the **limits** of validity of this **abstraction** are seen and new notions developed" (1987, p.141-2).

3242

STRUCTURE GENESIS (Law of)²⁾

"Any **process** of **communication** among the **components** of a system, once initiated and maintained with some regularity, leads to the genesis of **social structure** among **communicators** within the system" (K. KRIPPENDORFF, 1986, p.43).

According to KRIPPENDORFF, "the law presupposes that the individual **components** exhibit some regularities (e.g. conditional preferences, statistical biases in response to **stimuli**, rational **behavior**) and participate in the system for some **time**. The speed of structural genesis increases with the **complexity** of the **communications**, with the number of participating **communicators**, and with the length in **time** of the **process**. The speed decreases with the **level** of awareness and the number of **messages** controlled by each **communicator**. However, the law holds irrespective of whether the result is anticipated or desirable" (Ibid).

Structural genesis can be related to various other systemic viewpoints. One is CHRISTALLER's theory of **hexagonal space filling organization**. Another is C. LAVILLE concept of **vortexes**. Another one is V. CSANYI's theory of **autogenetic organization** and still others, the recent D.K. HUTCHINS' **configuration entropy** concept and D. Mc NEIL's **model of toroidal organization fields**.

3243

STRUCTURE SYSTEM²⁾

(In **reconstructability analysis**) "A collection of (sub)systems with consistent **distributions**" (A. RAMER & L. LANDER, 1990, p.448).

The authors comment: "When interested primarily in the **relationships** among the **variables**, rather than the **distributions** of their values, we speak of structure systems simply as structures. (A structure system can also be introduced in terms of behavior systems or state-transition systems (KLIR, 1985)" (in KLIR, 1985; RAMER & LANDER, p.448)

"A structure is covering if the union of its **elements** contains all the **variables** of the system" (ibid).

3244

STRUCTURE TRIGGER^{1) - 2)}

Some **noise** in a system that reveals a hidden potential **order**.

R. VALLÉE argues that **noise** cannot *create* **order**, but that it can make visible some **implicit order**. This is the case "when, because of a variation of some **parameter** defining the **dynamics** (of a system), it reaches a **unstable equilibrium state**, where a variation, even very small, of its **state**, produced by some **environmental perturbation** (i.e. a **noise**), throws it in one of the possible evolutive branches at that **bifurcation point**" (1992c).

This is consonant with the so-called order from noise principle, as exemplified by von FOERSTER's box of disordered magnets, which however conceals potential order. It is also related to PRIGOGINE's **nucleation**.

3245

STRUCTURE: VARIABLE OR INVARIANT?¹⁾

The variable or invariant character of a system's structure is a subject of controversy since long (see for example J.L. LE MOIGNE, 1977, p.160-163).

It is now generally admitted that a structure is **diachronic** as well as **synchronic**: each of its instantaneous **states** is a peculiar aspect of its temporal **totality**.

In a mature system, only feeble **variations** of the structure remain possible and one comes quite close to **invariance**. There are however at least two special cases to consider:

- A growing system undergoes frequently significant structural changes (examples are the moult of insects or the **transformations** of an **organization** at its beginnings). However the basic structure is then already a finited **matrix** of the **set** of all possible instantaneous structures (the larva of a mosquito will never produce anything else than a mosquito).
- A **system faraway from equilibrium** and submitted to giant **fluctuations** tends to transform itself and its structures through

the **emergence** of **dissipative structures**. In such case the **emergence** of a new system, quite different of the original one is a distinct possibility. The new system would then be structured in a more complex way than the former one.

3246

STRUCTURES (Five Proposals on Organizational)⁴⁾

The following five proposals by H. BOUCHIKHI result of his study of the **process** of introduction of personal computers in the "Régie Autonome des Transports Parisiens" and are thus related to administrative **structuration** (1990, p.428-35).

It would be interesting to look for **isomorphies** in biological systems and in animal societies (See "**stigmergy**").

- "1. **Organizational** structures are a **set of rules** and **resources** *recursively* engaged in the **structuration** of **organizations**
2. **Organizational** structures are simultaneously medium and result of the **interactions** among participants
3. **Organizational structuration** expresses a dialectic **process** of **equilibrium** between the **organization** and its **environment**
4. **Organizational** structures are closely linked to the **cooperation** and competition stakes of the participants

Figure: see entry **STRUCTURES of a SYSTEM (Basic)**

5 **Organizational structuration** results of a multitude of local **processes** not all necessarily convergent".

BOUCHIKHI makes different interesting points:

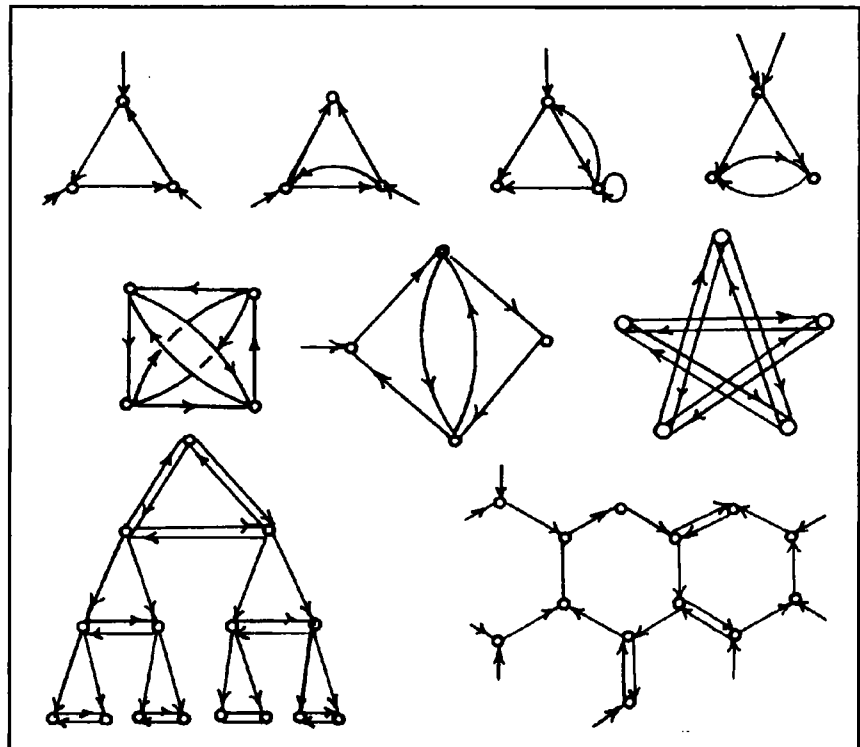
- a) **Organizational** structures are not rigidly imposed "from above" (or should not be!)
- b) **Organizational structuration** do not result in a static structure, achieved once and for all;
- c) Being the product of a **process**, it proceeds dynamically, by progressive propagation
- d) **Organizational structuration** is not necessarily a conscious **process**
- e) **Organizational** structures are not abstract; they result of the permanent **activity** of individuals

The following comment in a not-related paper by M. BUNGE (1988, p.7) seems opportune: "Interestingly enough, **cohesion** turns out not to be proportional to overall participation. Instead, it is maximal for middling participation – which is reasonable, since nil participation is incompatible with communality, whereas the participation of everyone in everyone else's affairs results in **anarchy**".

3247

STRUCTURES of a SYSTEM (Basic)²⁾

J.de ROSNAY enumerates thus the basic structures of any system:



Illustrating some organizational structures.
From M. KOCHEN: 1957, p. 37

- **Elements** or **components**, that can be counted and assembled into **categories**, families or **populations**: molecules, **cells**, inhabitants, machines, goods

- A **limit**, that defines the borders of the systems and separates it from the external world: **membranes**, the hide, the borders of a country

- **Stores** into which **elements** can be collected and wherein **energy**, **information** or **matter** may be kept: **organs**, tanks, computer memories, libraries, films

- A **communication net**, that permits exchanges of **energy**, **information** or **matter** among the systems **elements** or **stores**: nerves, arteries, roads, canals, cables, pipelines, etc..." (1990, p.98-9).

There are generally different kinds of **elements**, **subsystems**, **stores** and **communication nets** in a system. (**Elements** can constitute ordered **subsystems** of different types).

As to the **limit**, or border, it is as much an exchange structure as a **separator**.

see figure page 566

3248

STRUCTURES (Types of)²⁾

Two basic types of structures seem to appear in all classes of systems:

- Cellular structures, as for example in crystals, vegetal tissues, beehives, and **hexagonal organization** in human occupancy of space.

- branching structures in electric discharges, growing crystals, trees, **neuron networks**, and **hierarchic organization** in human systems.

Cellular structures seem to result from strong **environmental constraints** leading to an **involution process**.

Branching structures, result of oriented **bottom-up** or **top-down processes**, with **constraints dominant** in a favored direction. Branching structures can be mathematically modelled by **anastomic networks**.

These structures appear to be mostly stable, at least at the human **level of perception**. In fact, when they maintain themselves, it is through permanent **self-reproduction**.

A third class of structures are the interconnected looped structures, characteristic in **complex systems**, wherein **rules** controlling the numerous possible **interactions** lead to (generally imperfect) **organizational closure**, with more or less periodic (or **chaotic**) **self-reproduction**. This type of structures has been researched by M. KARSKY (1993, p.1412-21).

This author applied the looped structures **model** to what he calls "**delayed catastrophes**".

3249

SUBJECT³⁾ - 5)

"A purposeful individual or system" (R.L. ACKOFF & F.E. EMERY, 1972, p.34).

According to F. FRISCHNECHT and J.P.van GIGCH: "subject" generally represents any natural or artificial **entity** (e.g. **cells**, **organs**, **organisms**, human beings, social **groups**, institutions, computers) capable of *processing*, i.e. manipulation" (1989, p.240).

A subject is thus an active, more or less **autonomous entity** (even if **part** of an **entity** of higher **level** which may **control** it through an **order parameter**, in the sense of HAKEN **slaving principle**)

Human subjects are self-defined. They have viewpoints as **observers**. They relate to each others through **conflict**, **cooperation**, **consensus**, etc...

3250

SUBJECTION¹⁾ - 2)

"A governing **relation** of **asymmetrical dependence**" (J. FEIBLEMAN & J. FRIEND, 1969, p.36).

This is basically the **hierarchical mode** of **organization** of systems, in which the **survival** of some **elements** depends on other **elements** or **subsystems**.

For example, partial destruction of the nervous system or the **brain** leads to the loss of certain **functions** in the **living system**. In a somewhat similar sense, in an authoritarian society, the welfare and even at times the **survival** of the citizens depends on the **group** which controls the state.

The concept of subjection seems quite similar to the one of **slaving** in HAKEN's **synergetics**.

Asymmetry is not necessarily absolute, since what happens in the system depends on the relative position of the intervening **elements** in the **hierarchical order**. For example, a living being which loses a leg may survive, but its potential for action decreases heavily.

3251

SUBJECTIVITY (Epistemological)²⁾ - 3)

Condition of an observing and acting system which ascribes some of its own properties to the objective **universe** of which it is a part.

R. VALLÉE describes this condition in a more rigorous manner: "Through a **process** of "**inverse transfer**", induced by the reciprocal image **operator** $y \cdot 0^{-1} y$ (identifiable with the **inverse operator** when it exists, so when 0 is bijective), the properties of the functional image space (**topology**, **order**, **measure**...) are arbitrarily attributed to the **space** of all the possible original **evolution functions** x , generating what we can call the epistemological subjectivity of the system" (1990b, p.39).

It is interesting to note that, in the case of **conversation** in G. PASK mode, or **2nd. order cybernetics** of von FOERSTER, **consensus** when established does not define anything more than a domain of shared epistemological subjectivity.

It is obviously the opinion of these same authors.

3252

SUBLATION²⁾

The **hierarchical nonsymmetric** negation.

According to H. SABELLI, who transfers the term from dialectics: "It implies **evolution** in **time** and **similarity** between the terms of the contradiction. The opposition of the two terms of the contradiction is transient, their unity is essential and becomes permanent in a consistent and complete synthesis. The relation between thesis and antithesis and in the same manner the antithesis is sublated by the synthesis. Each term creates new properties by conserving, transcending and superseding the other terms" (1984, p.352)

3253

SUBSTITUTION (Forced)⁴⁾

A **process** in an **organization** through which the highest **decision maker** forces some definition or **action** upon the **organization**, because of the lack of useful **response** of the members of the **organization** to some challenge.

In some extreme cases, it is the **decision maker** himself who is substituted, as in political or military coups. When the challenge is putting the **organization** in danger (or seems to do) the forced substitution is a quite common reaction. As the substitute authority has generally no better **understanding** than the one it replaces, the results are seldom satisfactory, specially in a **long-term** perspective, even if in some extreme cases it can be the only way to avoid great losses, or even total destruction. Forced substitution reflects indeed a very serious flaw in the **organization**.

In effect, the real and permanent challenge is to enable the **stakeholders** in the **organization** to understand and accept their responsibilities and give them the means to do so.

Only **Generic Design** (WARFIELD), or **Unbounded Systems Thinking** (MITROFF and LINSTONE), or **Co-participative design** (Fuschl Group), or similar **methods of design** or **management** can prevent this class of disorders.

3254

SUBSTRATE¹⁾

The basic grid or ground on which a system can be constructed or self-organized.

The substrate must have some specific characteristics which makes it proper for the **development** of the system as for example be **homogeneous** or **isochronous**, or isometric, or **isotropic**.

A good **model** of a substrate is the squared grid on which CONWAY's **Game of Life** can be developed. There are also physical substrates, as in **catalysis** or crystallization **reactions**. Substrates can be illimited, but only in theory. Observe the difference with the **rules** of chess, in which the movement **rules** of the various chessmen makes the chessboard different for each kind.

3255

SUBSTRUCTURE ¹⁾ - 2)

A **structure** of a **subsystem**.

Substructures are normally correlated to each other at the same **level** of **complexity** and, at the same time, in a relation of subordination to the global **structures** of the system.

3256

SUBSUMPTION ¹⁾ - 3) - 4)

The ordering of a **set** of **concepts** in a hierarchical unity.

J. WARFIELD states: "Subsumption is relevant not only to the **organization** of **knowledge** in ways that facilitates its interpretation and utility, but also to **components** of **organizations**" (1990, p.290).

And: "Subsumption replaces "interdisciplinary", "aggregative", or "integrative", in **situations** involving the bringing together of all available relevant **knowledge** to **construct** a new organic **conceptual whole**" (pers. communication, 1991).

"(Subsumption) places no artificial limits on the sources of the **concepts** to be **aggregated** and thus admits actors to the discussion who are not obsessed with "disciplines". At the same time it allows for the possibility that an area of interest which has achieved subsumption of relevant **knowledge** to a high degree of quality may still be called a "discipline" in the academic sense" (1990b, p.290).

Remains to hope and see if obstinate "disciplinarians" will be heedful!

Subsumption must "increase the scope of the **model** without removing its previous **content**. Movement such as this is an antidote to the disease called "hardening of the **categories**", which is often found as a glue that holds inadequate **frames** in place" (WARFIELD, 1989, p.16).

And: "A **subsumptive transformation** implies bringing together diverse views and ideas and transforming those by **aggregating** them and **integrating** them into a new and more encompassing perspective" (1990a, p.69-70).

→ **Supersumption**

3257

SUBSUMPTION ARCHITECTURE ¹⁾ - 2) - 5)

The construction of complex **behaviors** in robots, by **interactions** of simpler ones.

This concept has been introduced by R. BROOKS (1989), and is based on the belief that intelligence does not necessarily needs reason.

According to BROOKS, "... complex **behavior** becomes possible in a robot only when there are simpler **behaviors** present that it may subsume" (A.K. DEWDNEY, 1992, p.19).

P. WALLICH states that "complex **behaviors** such as exploration of the **environment** are built up from simple ones like moving a single leg..."

In this way it is possible to avoid "the conventional A.I. impasse of trying to construct and maintain a consistent logical **model** of the outside world" (1991, p.86).

Considering the **complexity** of the "outside world", it is now obvious that, in the present state of the art, it would be almost impossible to construct an efficient general **algorithm** into an **automata**. Furthermore, even in man, rational intelligence is neither needed nor used in many basic **behaviors**.

3258

SUBSUMPTIVE TRANSFORMATION ²⁾ - 4)

"(The) bringing together (of) diverse views and ideas and transforming those by **aggregating** and **integrating** them into a new and more encompassing perspective" (1990a, p.60-70).

J. WARFIELD and M. AYIKU state: "In seeking a subsumption transformation, three fundamental assumptions are involved:

- the assumption of **continuity**:... people will not relinquish an internalized long held **framework** discontinuously... Consequently, any new **framework** that is proposed must *subsume* (i.e. incorporate, but go beyond) the old **framework**
- the assumption of increased cognitive burden:... Since the new **framework** subsumes the old one, it necessarily involves increased cognitive burden because it incorporate more concepts and requires a new **web** of **interactions** among them to permit adequate interpretations.
- the assumption of necessary cognitive enhancement:... If the burden of **cognition** is increased, then there must be provided means of enhancing cognitive capability in order to compensate for the increased burden" (1989, p.27 - abridged).

This is very important for **systemics**, which produce indeed an "increased cognitive burden" and seems at times to break **continuity** with long hold conceptual **frameworks**. The authors have put their fingers on some of the main difficulties to communicate **systemic viewpoints**.

3259

SUBSYSTEM ¹⁾

"An **element** or functional **component** of a larger system which fulfills the conditions of a system in itself, but which also plays a specialized role in the **operation** of the larger system" (V. CSANYI, 1993, p.67).

According to CSANYI, subsystems are "...communities of simultaneously **replicating components**".

The subsystem is thus simultaneously an **interacting component** in a **suprasystem** and in its own right a system made of **interacting components**.

This author explains that subsystems result in a progressive way from the increase of specific and different **replicative cycles** during the **process** of **autogenesis** in the recently shaped system: "Their **components** are separated from others by their participation in **co-replication**". He adds that: "As **time** passes, **replicative coordination** of various supercycles develop and fidelity of **replication** increases" (1993, p.263) As a result, functional **differentiation** and **cooperation** grow on par.

CSANYI's "supercycles" are the primeval form or M. EIGEN's **hypercycles**, which are thus stabilized supercycles.

A subsystem can in most cases be clearly recognized because it performs a specific **function**.

Subsystems are generally made of numerous **components**. As a rule, they interact with each other in specific ways. They frequently exchange their products and the **output** of one of them may be an **input** for another.

Most of them are critical for the system: the demise of one of them generally brings along the destruction of the whole system within a short **time**. This is specially true when the system is strongly **integrated**.

M. BUNGE observes: "If a system does have subsystems, not just **components**, then the **cohesion** of the subsystems competes with that of the overall system" (1979, p.37). This may explain why, in very **complex systems** whose global **coherence** is costly and difficult to maintain, some subsystems may turn more or less **parasitic** of their own system: Bureaucracy could be an example.

3260

SUBSYSTEMS (The 20 critical) ¹⁾ - 2)

James G. and Jessie MILLER describe in the following way the 20 critical subsystems in **living systems** (1990, p.159):

Subsystems which Process both Matter Energy and Information

1. **Reproducer**, the subsystem which is capable of giving rise to other systems similar to the one it is in.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

2. **Boundary**, the subsystem at the perimeter of a system that holds together the **components** which make up the system, protects them from **environmental stresses**, and excludes or permits entry to various sorts of **matter-energy** and **information**.

Subsystems which Process Matter-Energy

3. **Ingestor**, the subsystem which brings **matter-energy** across the system **boundary** from the **environment**.

4. **Distributor**, the subsystem which carries **inputs** from outside the system or **outputs** from its subsystems around the system to each **component**.

5. **Converter**, the subsystem which changes certain **inputs** to the system into forms more useful for the special **processes** of that particular system.

6. **Producer**, the subsystem which forms stable associations that endure for significant **periods** among **matter-energy inputs** to the system or **outputs** from its **converter**, the materials synthesized being for **growth**, damage repair, or replacement of **components** of the system, or for providing **energy** for moving or constituting the system's **outputs** of products or **information markers** to its **suprasystem**.

7. **Matter-energy storage**, the subsystem which retains in the system, for different **periods of time**, deposits of various sorts of **matter-energy**.

8. **Extruder**, the subsystem which transmits **matter-energy** out of the system in the forms of products or **wastes**.

9. **Motor**, the subsystem which moves the system or **parts** of it in relation to **part** or all of its **environment** or moves **components** of its **environment** in relation to each other.

10. **Supporter**, the subsystem which maintains the proper spatial **relationships** among **components** of the system, so that they can interact without weighting each other down or **crowding** each other.

Subsystems which Process Information

11. **Input transducer**, the **sensor** subsystem which brings **markers** bearing **information** in to the system, changing them to other **matter-energy forms** suitable for transmission within it.

12. **Internal transducer**, the sensory subsystem which receives, from subsystems or **components** within the system, **markers** bearing **information** about significant alterations in those subsystems or **components**, changing them to other **matter-energy forms** of a sort which can be transmitted within it.

13. **Channel and net**, the subsystem composed of a single route in physical **space**, or multiple interconnected routes, by which **markers** bearing **information** are transmitted to all **parts** of the system.

14. **Timer**, the subsystem which transmits to the **decider** **information** about **time-related states** of the **environment** or of **components** of the system. This **information** signals the **decider** of the system or **deciders** of subsystems to start, stop, alter the **rate**, or advance or delay the **phase** of one or more of the system's **processes**, thus coordinating them in **time**.

15. **Decoder**, the subsystem which alters the **code of information input** to it through the **input transducer** or **internal transducer** into a "private" **code** that can be used internally by the system.

16. **Associator**, the subsystem which carries out the first stage of the **learning process**, forming enduring associations among items of **information** in the system.

17. **Memory**, the subsystem which carries out the second stage of the **learning process**, storing various sorts of **information** in the system for different **periods of time**.

18. **Decider**, the executive subsystem which receives **information inputs** from all other subsystems and transmits to them **information outputs** that **control** the entire system.

19. **Encoder**, the subsystem which alters the **code of information input** to it from other **information processing** subsystems, from a "private" **code** used internally by the system into a "public" **code** which can be interpreted by other systems in its **environment**.

20. **Output transducer**, the subsystem which puts out **markers** bearing **information** from the system, changing **markers** within the system into other **matter-energy forms** which can be transmitted over **channels** in the system's **environment**.

In J.G. MILLER's original versions (1965, 1978), only 19 critical subsystems were described. The 20th., i.e. the "timer" was introduced by J. and J. MILLER (1990)

Note: The 20 critical subsystems are registered in their own alphabetic order in this encyclopedia.

3261

SUMMATION TIME^{1) - 2)}

"... a finite **period** of grace... such that two pulses arriving within such a **time period** still act as if they had been **simultaneous**" (J.von NEUMANN, 1958, p.55-56).

von NEUMANN defines summation time in relation to the transmission of **simultaneous** nervous impulses. A curious consequence is that *perceived simultaneity* is somehow slightly sequential. Summation time is thus necessary for any coherent global **perception**, even if supposedly **simultaneous**.

This is an interesting view, if connected with the concept of **parallel processing**: the interconnection of sequences processed in parallel is necessarily *somewhat* sequential!

3262

SUMMATIVITY²⁾

Process in which the "...variations of any **element** depend upon that **element** alone and **variations** of the **whole** system represent a sum of **variations** of its **elements** taken independently of each other (there is no **interaction** in this case)" (I. BLAUBERG et al., 1977, p.54-55).

This concept seems self-defeating. If the system "is more than the sum of its **parts**" the existence of **interactions** is indispensable and obvious. Conversely, if there are no internal **interactions**, but only an array of unconnected **transformations** of **elements**, there is no system.

The situation of simple summativity does not even seem to exist in **composite systems**, wherein at least there are global statistical **interrelations**.

3263

SUNK-COST FALLACY¹⁾⁵⁾

"The human tendency to judge options according to the size of previous investments rather than the size of the expected return" (P. AYTON & H. ARKES, 1998, p.40)

The authors state: "Truly rational **choices** would be made only after weighing up future **costs** and benefits. Past **costs** and benefits are quite irrelevant" (Ibid)

To let oneself into the sunk-cost fallacy leads to "throw good money after bad", i.e. to transform a still available **resource** into a highly probable loss.

This **behavior** can easily be observed in the stock market. It was also the irrationality that dominated the Vietnam war and led to this tremendous fiasco.

3264

SUPER-, SUPRA-¹⁾

Two prefixes used to generally indicate a higher **level** in **concepts**, **models** and **systems**.

These are practically undistinguishable synonyms.

3265

SUPERCYCLE¹⁾

An original incipient **replicative cycle** that appears during the **autogenetic process** of a system.

According to V. CSANYI who introduces the concept, supercycles appear if there is at least one **cycle** of **component-producing processes**, duly activated by **energy inputs** when the **autogenetic process** sets in, eventually generating a full-blown **autopoietic** system.

In **time**, different **replicative** supercycles become more stable and originate cyclically interrelated **subsystems**. At that **stage**, they can be assimilated to M. EIGEN's **hypercycles**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3266

SUPERORGANISM¹⁾

"An insect society that possesses features of organization analogous to the physiological processes of individual organism" (Th. SEELEY, 1989, p.548).

The term was coined by W.M. WHEELER (1919). It was a forerunner of the **organismic** viewpoint and of **self-organization** and **dissipative structuration models**.

3267

SUPERPOSITION (Principle of)²⁾

J. MILSUM enounces: "The principle of superposition states that a system responds to each of several **inputs** as if the others were not present" (1968, p.10)

This could be totally true only in **linear systems**, i. e. systems not interconnected in a complex way.

3268

SUPERSUMPTION^{1) - 3)}

"The ripping away of a concept from its proper place in a **context**, and elevating it to undeserved status" (J. WARFIELD, 1991, pers comm.).

This is the opposite of **subsumption**.

WARFIELD uses the example of the so-called "economic man" as the not otherwise qualified subject of economic science, thus supersuming one particular aspect of men's **behavior** and "thereby perpetuate a defective, arbitrary defined, set of ideas about human **behavior**" (1990 b, p.291).

→ **Subsumption**

3269

SUPPORTER^{1) - 2)}

"The **subsystem** which moves the system or **parts** of it in relation to part or all of its **environment** or moves **components** of its **environment** in relation to each other".

This is one of the **20 critical subsystems** in J.G. MILLER **taxonomy of living systems** (1978, p.3).

3270

SUPRA-HUMAN SYSTEMS¹⁾⁴⁾

This notion has been introduced by F. ROBB (1992)

According to ROBB very vast and developed human systems escape essentially out of the **control** of their individual participants.

While such supra-systems are initially **bottom-up** constructions they end up exercising a **top-down** control on their participants.

The following reasons seem significant:

- statistically, each member of the society is practically powerless at the supra-level. He is just carried along by the massive **flow** of

the famous "silent majority", even if that flow reflects merely a **herd-effect** (the so-called "public opinion")

- structurally, the individual member find himself generally closely encased (and even ensnared) within some **social structure** (institution, **organization**, business) that he has been more or less obliged to join to prosper (or simply survive) personally
- the two former aspects have systemic undertones: mainly, SABELLI's principle about "**priority of the simple, supremacy of the complex**" traduces itself as a fundamental **dissymmetry** between levels in highly differentiated complex systems.

The general impotence of the isolated individual explains probably the existence of lobbies, pressure-groups, cartels, and even mafias which are **coalitions** of individuals trying to recuperate or obtain some control on society. Of course in such cases **symbiosis** turns into **parasitism**.

Anyhow, modern mass-societies are becoming more and more similar to global **self-organizing automata**.

→ **Cross-level research; Crowding effects; Dissipative structuration; Institutionalization; Network (Evolutionary); Proxemics; Superorganism**

3271

SUPRASYSTEM¹⁾

A system of higher **order** in relation to some systems or **subsystems** of lower **order**.

While sometimes confused with "**metasystem**", it seems more related to **models of concrete systems**.

K. BERRIEN proposed some criteria for characterization of the suprasystem:

"Systems may produce useful or useless **outputs**, as determined by the suprasystem.

"Suprasystems select the **outputs** of their **subsystems** which are useful; contrarywise, the suprasystem rejects useless **outputs** from its own **subsystems**" (1968, p.33).

BERRIEN also considered that the **universe** could be represented as a **nesting** of systems, within systems, within systems; etc... Furthermore, the emergence of suprasystems corresponds to new **levels of emergence of complexity**. This view was later on confirmed by PRIGOGINE's **emergent dissipative structurations** at **bifurcation** points in systems **far from thermodynamic equilibrium**.

It also corresponds to J. STULMAN's concept of **fields** within **fields**, within **fields**... (1968-75)

R. VALLÉE writes: "...it is not surprising that the consideration of the pair **subject-object**, or **subject-subject**, that is to say of a super-system, at a **meta-level**, can bring great conceptual simplifications. This super-system, or **universe**, has the great advantage of being the one and only system to possess no border and,

hence, no **environment**" (1992d, p.26). This total **universe** is however purely theoretical. The concept can be used only in a willful manner by deciding that the chosen super- or supra-system escapes from **Gödelian** limitations, i.e. by suppressing any supra-supra system, at the eventual risk to run into logical contradictions.

B. BANATHY gives a different definition of the suprasystem: "A system made up of a number of **component** systems" (1973, p.88).

The terms "**supersystem**" and "**metasystem**" also appear frequently in systemic literature, in a very close sense.

Obviously, many authors sensed this kind of **hierarchical** or **embedding** relation, in somewhat different shades of meaning and it should be very difficult and even inappropriate to decide in favor of one or another.

We should merely propose to use "**metasystem**" in the sense of "controlling, or relevant **environment**", while the "suprasystem" (or "supersystem"), in a somewhat different sense, should be the global **environment** of its **component** systems.

This is of course also debatable, because it is then no more than a system of higher **level**.

According to BERRIEN, an important property of the suprasystem is that it "... can slough off some noncontributing **subsystems** and encapsulate or generate replacements" (1968, p.85).

BERRIEN wrote that this is precisely a property of biological systems. It seems to be extensible to **social systems**.

3272

SURROGATE WORLD¹⁾²⁾

A constructed **model** of a factual **situation**.

This important concept has been introduced by St. BEER (1973), who described the fictional way in which models are used by many people. BEER writes: "The model intervenes between the manager and the situation. It must do this: it is a kind of **filter** intended to cut out **noise** and enhance **perception** of meaningful **patterns**" (p. 199)

Of course, as explained by BEER, two very serious problems appear in many cases:

- "the model may be no good". This is because it depends on the **mental frame** or **reference frame** of the **modeller**, which may be incomplete, inadequate and /or distorted
- "people often begin to mistake the model for the **reality**- and start managing the model instead" (ibid)

Obviously, reality follows its own course meanwhile, either impervious to our mirage, or worse, reacting to it in an unexpected way

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Many mistakes and even disasters in business, economy, politics and generally human affairs do result of this kind of misguided use of models which are not recognized as incorrect surrogates

→ **Model**

3273

SURVIVAL (Conditions of)¹⁾

There seems to be two basic conditions for any systems survival:

- maintain its basic adaptive **fitness** within its specific **environment**;
- maintain its internal **organization**, and specially its **organizational closure** and internal **regulations**.

Of course, its **environment** must be sufficiently **stable** as to spare it unconquerable challenges.

3274

SUSTAINABILITY¹⁾⁴⁾

Any sustainable **process**- and still more so any **complex system**- depends obviously from the use of the **resources** in such a way as not exhaust them.

Sustainability cannot be maintained for ever through **linear processes**. In fact it is necessary based on the **interdependence** in the **relationship** of the process or system with its significant **environment**.

Runaway processes are particularly dangerous for sustainability, which can generally not be restored after such episodes.

Many present economical and ecological processes are obviously unsustainable at **long**- and possibly even at **medium-term**. If the need for permanent balanced re-equilibrated **feedbacks** with their input sources, for example by **recycling**, is not understood in due time, **collapses** could become unavoidable

3275

SUSTAINABILITY (Supply side)²⁾

T.F.H. ALLEN, who developed this **model** recommends the following steps (**hierarchically** organized), to create the general conditions for sustainability in **complex systems**:

- manage for whole **ecosystems**, not **resources**
- manage from the **context** to facilitate internal functioning: the healthy **ecosystems** in context subsidize the effort
- use **positive feedbacks** to achieve systems **change** (1998, p. 4)

In short, sustainability of **processes** must be subordinated to the system's sustainability

which in turn can be maintained only through a permanent **symbiosis** of the system with its **environment**.

Of course such a symbiosis implies some aspects that frequently remain hidden, as for example:

- the system's **outputs** must be carefully managed in order to avoid spoiling the environment
- technical **change** can (and generally does) modify the balance between the system and its environment. Such a change should be carefully scrutinized. Indeed a **change** can be initially beneficial and turn negative in the long run or it may be costly at the beginning and become positive later on
- the use of positive feedbacks to achieve systems change should be cautious, lest they lead to a global and possibly irreversible loss of **dynamic stability**, i.e. **long term** sustainability

3276

SUSTAINABLE^{1) - 4)}

Character of a **process** that can be maintained in a permanent way.

A systemic **process** is sustainable in this sense if a regular and permanent **input** of needed **resources** is guaranteed and if the **process** does not end up choked by its own products.

In M. DODDS and G. JAROS words: "... the **environment** is not a neutral laboratory but a **stakeholder** with needs of its own" (1994, p.14).

The chances for a **process** to remain sustainable are poor if it uses up an ever growing quantity of **critical inputs**: such a **situation** normally leads to scarcity or exhaustion of the **resource** and asphyxy of the **process**. Thus only **steady state processes** can be sustained *in the long run*, normally after a progressively slowing down **growth phase**.

This is a very important practical notion for any systemic **process** of **development**.

→ "**Economics in systemic terms**".

3277

SWAMPING^{1) - 4)}

The overwhelming of a **signal** by a much more powerful one.

This is the case for overlapping radio **signals**, when the more powerful one drowns the feebler one.

Analogically, a mass belief drowns the less powerful opinions of minorities or individuals, either by suppressing them in a definitive way, or by covering their voice until relenting. Recent examples are the resurgence of long swamped religious practice or local nationalisms in the former U.S.S.R.

3278

SWARM^{1) - 2)}

A large group of **elements**, with a more or less organized collective **behavior**.

In nature, insects form swarms. Fish shoals are also swarms. In both cases the formation of the swarm results from reciprocal **perception**. The swarm is probably the most elemental form of **sociosystem** and corresponds to some benefits individuals obtain from close proximity in the swarm, as for example relative protection against predators.

→ **Bottom up; Dictyostelium discoideum; Herd effects; Intelligence (Distributed artificial); Parallel distributed processing; Pheromone; School; Shoal; Sociality; Somatic ecology; Stigmergy**

3279

SWARM INTELLIGENCE¹⁾⁴⁾

The capacity of a number of interacting simple **elements** to developed coordinated **group behavior**.

L. STEELS (Brussels Free University) explores "**swarm intelligence**", i.e. coherent **emergent** collective **behavior** in **groups** of artificial and individually **autonomous agents**. Using BROOKS' **subsumption architecture** as a tool for functional **self-organization**, he defines a kind of *robots ecology* (1990).

The **methodology** used is akin to collaborative **communication**, based on pheromones, in social insects. Each participant needs only reduced **perception** and **decision** capacities: global **organization** appears spontaneously through **communication**.

The terms "swarm intelligence" were introduced by DENEUBOURG et al (1992). It related however in this context to "the **simulation** of the termites nest-building **behavior** on a computer by applying a very simple "**stigmergic algorithm**".

J. HOFFMEYER criticized this view: "I am not going to defend the view that the collective behavior of termites deserves to be called intelligence" (1995, p. 20). while this is semantically commendable, it seems to miss the point. Hoffmeyer himself describes the process as "distributed **problem solving**" (ibid). As such, swarm intelligence, being it in insect societies, **robots**...or of course human societies is basically a **communication process** in which the individuals take part each in accordance with its **perceptive** possibilities, and **decision** and **action** ones. They could be considered as a discontinuous collective **boundary** between the swarm (or system) and its **environment**.

Swarm intelligence is now modeled by groups of **robots** whose individual cognitive abilities are very limited, but who may become able to execute complex tasks by interacting in accordance to some **rules**. (A. MARTINOLI et al., p. 56-62, 2002)

Moreover, these **interactions** are triggered by specific **events** in the **environment**.

The main concepts of swarm intelligence have been derived from the **observation** of social insects (ants, bees) and fish **schools**. Two basic conditions seem to be indispensable.

- 1) The existence of a **perception** capacity for some well specific conditions, **forms**, or **activities** in the environment
- 2) The existence of a specific **mode** of **communication** as for ex. **pheromones** or electromagnetic **signals**

Human societies have evolved high level swarm intelligence through very differentiated and precise capacities of perception and communication systems (a **variety** of coded natural or technical **languages**). Moreover, all such processes depend on **learning** and transmission through **time** or registered results (i.e. some form of **memory**)

→ **Algorithm; Algorithm (Back-propagation); Bottom up; Cybernetics (2nd); Dictyostelium discoideum; Herd effects; Intelligence (Distributed artificial); Parallel distributed processing; Pheromone; School; Shoal; Sociality; Somatic Ecology; Stigmergy**

3280

SWIRL ²⁾

An eddy, **vortex**, whirl, or whirlpool.

A sometimes used synonym for a gyrating or spiraling movement in two or three dimensions. Swirls are generated by interacting **fields**

3281

SWITCHING ^{1) - 2)}

The crossing of a system or **population** from one **domain of attraction** to another.

As to **populations**, C. HOLLING explains: "It has indeed been found that fecundity and mortality will generate **domains of attraction**, with each domain separated from other by characteristic extinction and escape **thresholds** (1965).

"As long as the **populations** remain within one **domain**, they have a consistent and regular form of **behavior**. If they pass a **boundary** to the **domain** by **chance** or through intervention by man, then the **behavior** suddenly changes..." (1976, p.80).

A similar situation has been shown by H. LABORIT in physio-psychological **processes** switching from resistance to submission, or conversely (1954, p.3).

→ "Catastrophe"

3282

SYLLOGISM (Bayesian)

→ **Bayesian syllogism**

3283

SYMBIOGENESIS ¹⁾²⁾⁴⁾

(This replaces the existing entry)

The **emergence** of a higher form of **organization** as result of growing **symbiosis** between two (or more) different systems.

P. CORNING (1998b, p. 23) establishes the priority of "an obscure school of the 19th and early 20th Russian botanists". He quotes MERZHKOVSKY who coined the term "sybiogenesis" and defined it as "the origin of **organisms** through combination and unification of two or many beings, entering into **symbiosis**" (1920, p. 65)

CORNING also quotes another russian theorist, B.M. KOZO-POLYANSKY who observed that: "The theory of sybiogenesis is a theory of **selection** relying on the physiology of **symbiosis** (1932,p.25) and in no way incompatible with Darwinian evolution".

F. CAPRA synthesizes in the following terms a basic discovery by Lynn MARGULIS: "The sudden appearance of nucleated **cells** in the history of **evolution** and the discovery that their organelles are distinct self-reproducing **organisms** led (her) to the conclusion that nucleated cells have evolved through **long term symbiosis**, the permanent living together of various bacteria and other microorganisms" (1997, p. 242) (Also L. MARGULIS, 1981, 1993) and L. MARGULIS & M. McMENAMIN (Eds.), 1993).

By an adequate combination of characters, complex sybiogenetic **organisms** can survive and evolve in conditions that would not be suitable for their **parts** in separate forms

CAPRA even observes that many old myths ("sphinxes, mermaids, griffons, centaurs...") seem to convey in an implicit way the idea of sybiogenesis. He adds: "Somehow the collective human unconscious seem to have known from ancient times that **long-term symbioses** are profoundly beneficial for all life" (Ibid, p.245).

It seems now that some new forms of sybiogenesis have surfaced in techniques. Many modern complex **artifacts** are results of the convergence, **co-adaptation** and final **integration** of a number of simpler techniques: the steel and the diesel motorships, the car and the aircraft are outstanding examples.

It seems even possible that a similar **phenomenon** plays a role in the **organization** of complex **social systems** and are still presently fully active (crf. the **globalization process**).

The more general systemic significance of the concept is obviously based on complementarity between compatible systems with benefits for both, until the fusion reaches **irreversibility**, i.e. when the individual **parts** cannot anymore survive independently.

The same concept also emerged in W. SCHWEMMLER's work (1991), together with a kind of operative **process model**, namely his **toolkit principle**.

3284

SYMBIONT ¹⁾⁴⁾⁵⁾

An **organism** that lives in close **relationship** with another one.

The symbiont's relation with its co-symbiont tends to become permanent and may lead to closer forms of **association**, including down-right **parasitism**, or complete fusion leading eventually to the **emergence** of a more **complex system** at a higher level of **integration**. (W. SCHWEMMLER, 1991, p. 97-99)

3285

SYMBIOSIS ¹⁾

"An exchange between systems in which a **part** of each system's **autonomy** is sacrificed in order to enhance a superordinate system **relationship**" (Ch. SMITH, 1986, p.209).

The term symbiosis was introduced by the german mycologist A.De BARY (1879)

In symbiosis, "one or more system may benefit and none are harmed" (UNESCO-UNEP, 1983, p.26).

Ch. SMITH comments: "The stronger superordinate **relationship** ultimately increases each of the original system's **resilience**..." and...

"Systems are observed to be more symbiotic and more communicative with other systems in their **environment** after a **dissipative transformation process**"

According to E. JANTSCH: "The **emergence** of pre-cellular, self-reproducing life forms is an example of a **dissipative change** that resulted in a symbiotic **relationship**. Two classes of molecules catalyzed each other's development by combining. Each molecule offered something that the other molecule did not have: the **best information** carriers joined with an excellent **catalyst** to make possible the preservation of a system and the development of a means of transferring complex information" (in SMITH, 1986, p.209).

M. MARUYAMA's **deviation-amplifying mutual causal process** is possibly a workable **model** of symbiosis, which has to see with opposite **complementarity** in **growth processes** (1963).

MARUYAMA also states: "... the basic principle of the biological and social universe is increase of diversification, **heterogeneity** and symbiotization. What survives is not the strongest, but the most symbiotic" (1976, p.202).

C. BRESCH has given a good embracing outline of symbiosis by **catalysis** in his book about **evolution** (1977).

R. DAWKINS makes the following - and somewhat startling - comment: "I speculate that we shall come to accept the more radical idea that each of our genes is a symbiotic unit. We are gigantic **colonies** of symbiotic genes" (1978, p.196).

The tendency to symbiosis may well be a generic feature of any **sociogenesis**, including for human societies.

Symbiosis is not to be confused with **commensalism**, nor **parasitism**.

Global **homeostasis** in very complex meta-systems (e.g. in economy, in ecology) may be understood as a result of the symbiosis of numerous participant systems.

In spite of the existence of various distinct and sometimes nearly conflicting definitions of symbiosis, P. CORNING states: "Nevertheless, there seems to be general agreement that symbiosis refers to the **relationships** of various kinds between biological entities and the functional **processes** that arise from those relationships" (1998b, p. 24). CORNING adds: "**Synergy** on the other hand, refers to the interdependent functional **effects** (the bioeconomic "pay offs") of symbiosis- among other cooperative **phenomena**".

Moreover, while "...all symbioses produce synergetic effects,...many forms of synergy are not the results of symbiosis" (Ibid p. 24-25)

Compare also with V. CSANYI **zero-system**.

3286

SYMBIOTIC PARTNERSHIP²⁾⁴⁾

The **association** of two or more distinct vegetal and/or animal species producing benefits and/or protection to both.

This seems to be a step previous to integrated **symbiosis**, or at least could be.

An example at a practically automatic **level** is the **reaction** of a tree, parasited by some insect. The tree emits **pheromones** as a response to the attack and these attract parasites of the parasite.

P. CORNING (2001, p.8-9) gives examples of symbiotic partnership. One is between the African honey guide bird, who discovers a hive and a badger, who is able to dismember it. The bird gets the beeswax and the badger eats the honey.

Corning also cites the partnership of the same honeyguide bird with the nomadic northern Kenyan Boran people, with similar results.

Symbiotic partnership also exist at the simplest biological level. Corning even gives an example of multiple partnership in a single-celled protist: *Mixotricha paradoxa*.

Symbiotic partnership, whatever its level or **complexity**, is clearly a socializing **mechanism**, leading to **living systems** of higher degrees of integrated **organization**.

It is however different in nature from **herd effects** or **swarms** which gather individuals of the same species, mainly for reciprocal protection.

3287

SYMBOL^{1) - 3) - 4)}

1. "A **sign** that would lose the character which renders it a **sign** if there were no interpretant" (C.S. PEIRCE, in J. HOOPES, 1991, p.240).

2. "A **sign** that is a potential producer of a **response** to something which in turn is a potential producer of a **response** to something other than itself" (R.L. ACKOFF & F.E. EMERY, 1972, p.168).

3. "Something that represents something else, by **association** or convention" (AMERICAN HERITAGE DICTIONARY, p.1302).

PEIRCE's definition is what makes symbols important in systemics: It shows the importance of abstract **frames of reference** in individual **observers** and in **communities**.

A symbol seems to be basically an individual and collective human **memory** device, useful to maintain **sociality**. S GOONATILAKE observes that "Cave pictures were the earlier cases of the externalization of internally kept **images**. In fact, the later development of writing is traced to pictographic roots" (1991, p.86).

ACKOFF and EMERY's definition seems to be rooted in C.S. PEIRCE's own and on his **descriptions** of the various types of symbols (J. HOOPES, 1991, p.30-1 and 240). They observe that, according to S. LANGER (1948), a symbol is a **sign** that signifies a concept, while CH. MORRIS used it as a **sign of a sign**.

Most symbols are created by deliberate **association**, but are thereafter transmitted by imprinting, a **process** whose roots can be found in animal **behavior**, as shown by K. LORENZ.

K. STEINBUCH has given an interesting **model** of symbol formation with his "**learning matrices**".

H. MALTA MACEDO states that symbols "are the fixed mental **structures** that holds against the shapeless everlasting **flow** of sense-**data**" (1992, p.674).

R. GLANVILLE observes that: "We make reference (create a temporary identity) between that which is to be communicated and that which is to communicate it (roughly and loosely, between **meaning** and **symbol**)" (1992, p.661).

Symbols generally transmit subliminal **messages**, once they become incorporated within a given culture.

Many symbols become supports for concepts, and can easily "be combined with other symbols" In such cases "A combination of symbols hence represents a potential **association** of concepts" (F. HEYLIGHEN).

Unfortunately the interpretation of symbols **significance** is not always stable nor clear and, furthermore they may easily be manipulated.

See hereafter about **semantic** confusion introduced by the restricted **signification** of "symbols" as something manipulated by computers.

3288

SYMBOLIC POWER⁴⁾

A psychologic pressure exerted by a dominant individual through some visible manifestation of his/her power.

This concept was developed by the French sociologist Pierre BOURDIEU (1930-2002).

In this way, displays of material wealth, acquired academic ranking, military uniform, etc... are used to impress other people in order to inspire them respect, obedience, etc.

Symbolic power seems to have roots in animal territorial or ranking displays and has probably also sexual **connotations**.

3289

SYMBOLIC PROCESSING^{2) - 3)}

D. GREGORY writes: "A great deal of mischief and unnecessary excitement has been caused through the use of the phrase *symbolic processing*. Symbolic processing, as distinct from number crunching is what powerful Lisp machines were manufactured for. The focus of the **distinction** is the realization that computers are not restricted to the manipulation of numbers, but rather, they can be made to manipulate any kind of symbol which may or may not represent a number. What is overlooked of course, is that the difference is a difference in *our* eyes only: the **machine** is in no position to care one way or the other whether what it manipulates appears to us as a number or a word. And it does not care because what it manipulates has no ultimate **meaning** for it.

"To a machine, the symbols it shunts around are **syntactic patterns**: it is only when a user interacts with the **machine** that the **patterns** are given some final symbolic value that finds existence at a **semantic** experience in the user".

"... It is the key to understanding how PASK's **cybernetics** is quite different to the A.I. enterprise" (1993, p.63).

In other words, by careless use of terminology, man puts unwittingly his own ghost in the **machine** and mistakes it for real.

3290

SYMBOLIC VIOLENCE⁴⁾

The psycho-sociological pressure exerted in an education or **training process** by the teacher on the learner.

According to P. BOURDIEU, symbolic violence tends toward the transmission of a worldview (*Weltanschauung*) proper to the educator as a member of a specific socio-cultural **group**. It corresponds to sets of **values** and **norms**, and also **perceptions** and feelings typical of such a group.

In most cases symbolic violence is implicit and even unconscious in the educator. It can however become overt and translate into more or less subtle discrimination or even declared ostracism against the individual that does not "conform" with the approved type or does not readily accept the **rules** established by the dominant group.

It is obviously a general and very basic feature in all societies and at all levels.

Snobism, ridiculization, **exclusion** from some circles, etc., are forms of symbolic violence.

It seems to be a mental form of the physical exclusion in social animals or insects based on **pheromonal** differences.

3291

SYMMETRY¹⁾

"The **relation** in which the interchange of the **parts** does not involve any **change** in the **relation**" (J. FEIBLEMAN & J. FRIEND, 1969, p.32).

On the contrary, **asymmetry** implies such a **change**.

FEIBLEMAN and FRIEND give the following example "...The **relation** of the skin of an apple to the flesh is not the same as the **relation** of the flesh to the skin, and is therefore an **asymmetrical relation**... (however) grains of sand are symmetrical since an interchange of **parts** does not involve any **change** in their **relation**" (Ibid.).

A better example of **asymmetry** would be the **relation** between a subordinate and a senior in an **organization**. It is however quite difficult to imagine absolutely symmetrical **relations**, which would imply an also absolute reciprocal inertia of the **elements**.

According to the cited authors, **asymmetry** involves a **dynamics** tending toward a structural **equilibrium**. In their own words: "Since no **organization** is ever in complete **equilibrium**, the striving toward **equilibrium** is the equivalent of the reduction of **asymmetry** to **order** in **seriality**" (p.49).

However, **dissipative structuration** manifests the opposite **process**: **symmetry-breaking** leading to a higher **level** of **complexity**, generally more **asymmetric**.

Numerous types of **structural** symmetry are possible in two or three dimensions, since different symmetries can result of different rotations in **space**, for instance 90°, 60°, 45° or 30°. The most symmetric figures in 2- and 3-dimensional space are the circle and the sphere.

Crystals present various types of more or less perfect symmetries in three dimensions.

Symmetry is many times *presumed*. H. SABELLI observes: "The so-called postulates of symmetry are so widely accepted in physics that many as yet unobserved **phenomena** have been formulated for reasons of symmetry. However, symmetry breaks down in the most important **parameter**: **time**" (1984, p.356). And: "The consideration of **order** and **structure** is not sufficient. Even more important is that of **time-dependent**, changing orderings and **structurations**. The **process** of ordering is both logically and existentially prior to the static **order** that it generates" (p.357).

This is also the lesson of PRIGOGINE's **far-from-equilibrium thermodynamics**.

3292

SYMMETRY (Antagonistic)²⁾

"A systematic trend toward **adaptability** by the engendering of diverse competitors" (H.G. BURGER, 1967, p.221).

Enhanced **adaptability** is a result of increased **variety**, which can be obtained either by **differentiation** of new types distributed within a **population** or **specialization through competition** of similar **elements** or individuals.

3293

SYMMETRY (Hexagonal)²⁾

The hexagonal symmetry, that appears in many spatial **distributions**, seems to be a result of equalizing reciprocal pressures.

While pressure seems to expand as a **field** radially from a center and generate concentric **circular boundaries** of equal pressure, the reciprocal **limits** of different **fields** tend to adopt regular polygonal layouts, in accordance with the trend to fullest possible occupation of available **space**.

For examples see: "**Hexagonal space filling**".

3294

SYMMETRY (Pentagonal)²⁾

The fivefold symmetry appears in the **forms** of numerous natural systems, as well as in the **clusters** created by **diffusion limited aggregation (DLA)**, which, quoting I. STEWART: "... is baffling because the **rules** for forming the **clusters** do not involve any obvious fivefold symmetry" (1992, p.14).

Fivefold symmetry is also subjacent in the **FIBONACCI series** and the **golden proportion** to which its ratio tends. It seems thus an intrinsic natural property somehow mirrored by abstract number theory.

3295

SYMMETRY-BREAKING^{1) - 2)}

The destruction of symmetry in **space-time**.

J. COLLINS and I. STEWART write: "The simplest **oscillator network** that demonstrates symmetry-breaking consists of just two coupled, identical **oscillators**. Because they are identical, the system behaves in the same way if the **oscillators** are interchanged – that is the symmetry. While the symmetry remains unbroken, the two **oscillators** are in **phase**: they are **synchronized**. But when the symmetry breaks, **group** theory reveals that only one other **pattern** of **behavior** is possible: **antisynchrony**, in which the **oscillators** are half a **cycle** out of **phase** with each other. Not all symmetry need to be lost when symmetries break, however. The **antisynchronous** motion has its own symmetry: the **oscillation pattern** is unchanged if the two **oscillators** are interchanged and their respective **phases** shifted by half a **cycle**" (1994, p.38-9).

Symmetry-breaking is one of the very basic features of nature, possibly since the big-bang itself and is deeply connected with **thermodynamics**.

Classical **thermodynamics** already introduced **time dissymmetry** during the 19th century, even if this was not clearly perceived at the time (f. ex. in BOLTZMANN vain efforts to reconcile **reversibility** with **thermodynamics**). However, the full impact of **thermodynamics** became clear after PRIGOGINE's work on systems undergoing giant **fluctuations** and **dissipative structuration**. He definitively showed that, in the factual world, true **reversibility** is impossible, as a result of **time** symmetry breaking.

As **giant fluctuations** and **dissipative structuration** result of increasing **energy inputs**, it is "... an external **field** which imposes the way the symmetry must be broken". And "Thus the ability to break symmetries corresponds to an adaptive capacity... It is also an advantage to be able to break symmetries all the time, that is to maintain oneself just in the **vicinity** of the **phase transitions**, or in a self-organized **critical state**" (E. BONABEAU, 1993, p. 830-1).

E. JANTSCH states: "Passing from... the **thermodynamic** to the **dissipative structures level**, implies breaking the spatial symmetry between **subject** and **object**, **observer** and **observed**. This general breaking of spatial **isotropy** leads to a **non-equilibrium** world in which "**order through fluctuation**" can become an evolutionary principle" (1975, p.95). In synthesis, symmetry breaking leads to **dissymmetry**, which in turn leads to complementary **organization**.

3296

SYMMORPHOSIS²⁾⁴⁾

"The precise tuning of all structural **elements** to each other and to the overall functional system" (E. WEIBEL, 2000)

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This aspect of animal physiology is a yet quite insufficiently explored subject. R. DUDLEY who reviewed WEIBEL's book (2000, p. 557-558) insists on the interest to recognize the need for "compromise between varying demands and intrinsic **constraints** that has yielded present day **patterns** of physiological **adaptation**"

Symmorphosis seems to be to physiology what d'Arcy THOMPSON's research on structural differences in animal's **evolution** has been in anatomy. In both cases internal **constraints** between **structures** and physiological **processes** in animals are emphasized and it can be seen that conditions of **compatibility**, **cohesion** and **efficiency** among parts or **sub-systems** are unavoidable need for any type of **dynamic systems**.

→ Auto-genetic systems precursors; Entropy production (Theorem of minimum); Growth (Allometric); Synchronization; Synergy

3297

SYMPTOM¹⁾

Any **signal** or **event** that indicates some incipient **change** in a system or a systems **process**.

Symptoms are mostly systemic **phenomena**.

Such interpretation is important because symptoms must be perceived and their **perception** and interpretation depends on the nature and quality of the conceptual **frames of reference** of the **observer**. The symptom loses much of its meaning or may even be overlooked if it is seen in an unconnected way, without a good **understanding** of the inner **organization** of the affected system and of its **relations** with its **environment**.

3298

SYNAPSE⁵⁾

The small interval in a **neural network** at which a nervous impulse passes from the axon of an emitting neuron to the dendrite of a receptor **neuron**.

What happens in the synaptic interval (or cleft) is a quite complex **process of transmission**. The electric impulse from the axon is not directly transmitted to the receptor dendrite. It triggers a **sequence** of exchanges based on specific biochemical molecules, from the terminal knob of the axon to the receptor dendrite. After transmission the chemical signal is again transformed into an electrical impulse and the synaptic cleft returns to its potentially receptive state through specific **feedbacks**.

A better understanding can be obtained for instance from J.C. ECCLES's work (1977), J.Z. YOUNG's (1978) or more recently Rita CARTER's book (1978).

→ **Synaptic weights**

3299

SYNAPTIC WEIGHTS^{2) - 5)}

Balancing coefficients applied to the **inputs** of artificial **neurons** in a **network**.

This expression is derived from the biological "**threshold automat**" model of brain **neurons** (W.S. Mac CULLOCH and W. PITTS, 1943). The weighted **inputs** are subsumed and the result triggers the **element** action or inhibits it.

Neural networks "learn" through the progressive determination of the synaptic weights which correspond to repeated **inputs** of the same types. Values of the coefficients become progressively stabilized through **feedbacks** from the **outputs**, which themselves tend to stabilize.

see figure below

→ **Parallel Distributed Processing**

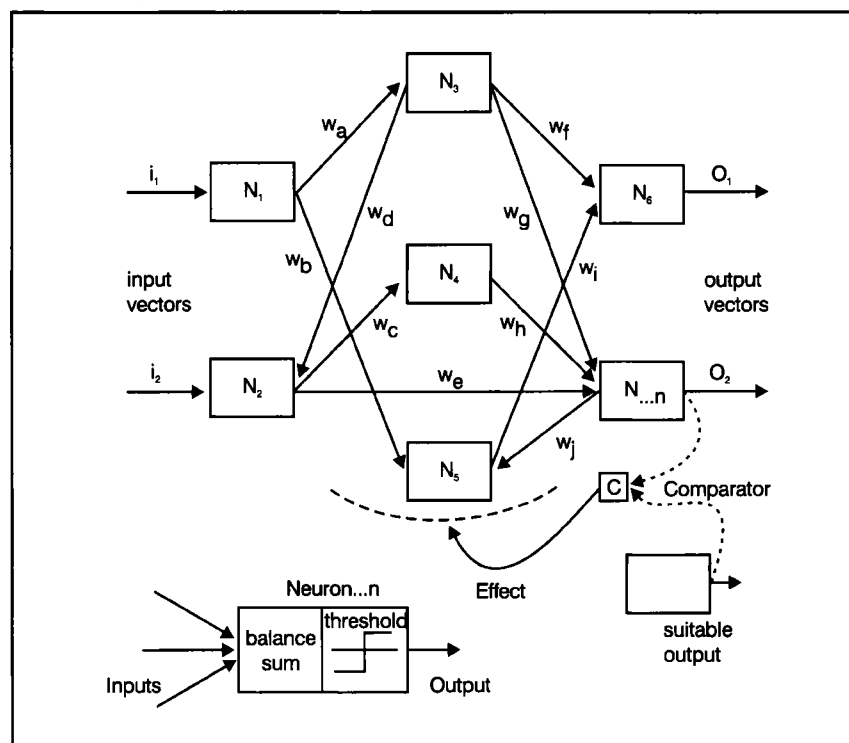
3300

SYNCHRONIC and DIACHRONIC^{1) - 3)}

Superficial exponents of structuralist concepts frequently oppose the **diachronic** aspects of **structures** to their **synchronic** aspects. Some even understand **structure** as a pure **synchronic** concept.

J.L. LE MOIGNE observes on this matter: "(PIAGET concluded that) **structuralism** is in fact a **method**, not a doctrine. He proposed a global approach describing the **object** as a **whole**, functioning and transforming itself (...): "The nature of the subject is to be a functioning

Figure: see entry **SYNAPTIC WEIGHTS**



Modifying Synaptic Weights.

Adapted from G. YAMIAOUI & J. L. AMAT - La Recherche. V. 24, N° 252 - March 1993

center and not the seat of a completed entity" (quote PIAGET, 1968, p.123). May the **object** not be perceived "as a bundle of **transformations**" (Ibid, p.124) operating and evolving only through its own operations?" this constant duality, or more precisely bipolarity of properties, being always simultaneously structuring and structured" (LE MOIGNE, 1990, p.11).

LE MOIGNE also quotes the Swiss linguist F.de SAUSSURE: "synchronic **truth** appears to be the negation of diachronic **truth** and, looking at the matter in a superficial way, one imagines that one must choose; in fact, this is not necessary as one of these **truth** does not excludes the other" (1990a, p.29)

In fact, a **structure** is **diachronic** as well as **synchronic**: each instantaneous **state** of the **structure** is an embodiment of its temporal **totality**.

3301

SYNCHRONICITY¹⁾

The coincidence in **time** of **events** or **patterns**.

The **concept** is somewhat ambiguous.

It could have an absolute theoretic **meaning**: two (or more) **events** are truly synchronic when they occur at the same instant. However, they could very well not appear as synchronic to different **observers**, while **observers** are who decide on synchronicity, *as they observe events*. Referentials are relative.

Furthermore, observed synchronicity is easily spurious. The simultaneous **observation** of many stars by an astronomer does not make their existence synchronous, nor even possibly contemporary of each others.

F. DAVID PEAT uses the concept in a somewhat dubious manner, quoting for example C.J. JUNG, who abundantly used it, speaking of "meaningful coincidence" (1988, p.1). What does however mean "meaningful" and for whom?

3302

SYNCHRONIZATION²⁾

Reciprocal **entrainment** between two or more **oscillators** with, in addition, exact lock-step of **phase**. (Adapted from S. STROGATZ and I. STEWART, 1993).

Synchronization is one of the most basic needs for securing and maintaining **coherence** in systems.

Synchronization corresponds to the emergence of an **attractor** between the various **periodic** movements of distinct **oscillators** that become **coupled**. The **attractor** is normally **cyclical**.

A.T. WINFREE discovered that, in a system comprising many **oscillators**: "... the system's **behavior** depends on the width of the **frequency** distribution. If the spread of **frequencies** is large compared with the **coupling**, the system always lapses into incoherence, just as if it were no coupling at all. As the spread decreases below a critical value, part of the system spontaneously "freezes" into **synchrony**" (STROGATZ & STEWART, 1993, p.73).

These authors add: "Synchronization emerges cooperatively. If a few **oscillators** happen to synchronize, their combined, coherent **signal** rises above the background din, exerting a strong effect on the others" (Ibid).

This is an effect quite comparable to **percolation** in **composite systems** (and possibly the key for explaining how **composite systems** may become more coherent, i.e. **integrated**).

Moreover: "When additional **oscillators** are pulled into the synchronized nucleus, they amplify its **signal**. This **positive feedback** leads to an acceleration outbreak of **synchrony**". However: "Some **oscillators** nonetheless remain unsynchronized because their **frequencies** are too far from the value at which the others have synchronized for the coupling to pull them in" (Ibid, p.74).

According to WINFREE (as quoted by STROGATZ and STEWART): "... mutual synchronization is strikingly analogous to a **phase transition** such as the freezing of water or the spontaneous magnetization of a ferromagnet. The width of the **oscillators' frequency distribution** plays the same role as does temperature and the alignment of **oscillator phases** in **time** is the counterpart of an alignment of molecules or electronic spins in **space**" (Ibid).

This is a significant new link between physics and biology. It confirms the status of synchronization as a **General Systems model** and even is a new example of the wide reach of some **systemic-cybernetic models**.

The role of **time** in the biological synchronization is also to be remarked. (KORZYBSKI's **time-binding**).

→ **Entrainment; Phase locking**

3303

SYNCHRONOUS (Anti-)²⁾

The character of two **phase locked oscillators** when one's minima correspond to the other's maxima.

A good example are the legs of a walking person: When one moves, the other rests on the ground.

3304

SYNCHRONY^{1) - 2)}

The interconnected **behavior** of two or more **oscillators** with similar **periodic rhythm** or **rhythms**.

A.T. WINFREE showed that synchrony may or may not be **stable** (1980).

S. STROGATZ and I. STEWART offer different examples of synchrony: perfect synchrony (identic and simultaneous **frequencies**); anti-synchrony (identic **frequencies**, but in polar opposition); two in synchrony and a third out of **phase**; two in synchrony and a third with a twice as fast **frequency**; etc.

These authors comment: "Synchrony is the most obvious case of a general effect called **phase locking**: many **oscillators** tracing out the same **pattern** but not necessarily in step. When two identical **oscillators** are coupled, there are exactly two possibilities: synchrony, a **phase** difference of zero, and antisynchrony, a **phase** difference of one half" (1993, p.71).

→ **Numbers (Prime)**

3305

SYNCHRONY (Symmetry breaking in)²⁾

Synchrony is not necessarily always symmetric.

S. STROGATZ and I. STEWART explain this: "**Symmetry breaking** governs the ways that coupled **oscillators** can behave. Synchrony is the most symmetrical single **state**, but as the strength of the **coupling** between **oscillators** changes, other **states** may appear. Two **oscillators** can couple in either synchronous or **antisynchronous** fashion,... corresponding roughly to the bipedal locomotion of a kangaroo or a person. Three **oscillators** can couple in four ways: synchrony; each one third of a **cycle** out of **phase** with the others...; two synchronous and one with an unrelated **phase**... or in

the peculiar rhythm of two **oscillators antisynchronous** and the third running twice as fast... This **pattern** is also the gait of a person walking slowly with the aid of a stick" (1993, p.72).

A growing **variety** of combinations can be produced by a growing number of **coupled oscillators**.

3306

SYNCRETISM¹⁾

The tendency to mutual **integration** of different **cultures** or belief systems.

Syncretism is obviously a **systemic phenomenon**. It has not yet however been much researched in systemic ways.

M. MARIYAMA's study of comparative **mindscapes** is an important contribution to the subject (1976, 1979, 1994).

3307

SYNECHISM²⁾³⁾

The tendency to regard everything as continuous.

This neologism was introduced by PEIRCE (see collected papers 1998) and is quoted by R. ROBERTSON (2001, p. 22)(who, by the way, observes "Peirce was always one to coin a new term, which often makes reading him a process of translation) (Ibid.)

Anyhow, the scope of Peirce's studies on **continuity** in **space** and in **time** shows him as a precursor of D. BOHM's "**implicate order**", based on **quanta**; of PRIGOGINE's **emergence** of more complex entities through **dissipative structuration** and even possibly of still more recent physics **models** that tend to consider any structured matter as a provisional "ripple" in the basic **space-time** continuum.

The similarity with SPENCER BROWN's **laws of form** using recursive **distinctions** is also intriguing and probably significant as signaling a **connection** between the concepts of "**whole**" and "**void**". (see J. ENGSTROM, 2001, p.25-66)

→ **Quantum vacuum**

3308

SYNERGETICS^{1) - 2)}

"An **interdisciplinary** field of research that deals with systems composed of many **subsystems**" (H. HAKEN, 1993, p.1015).

In a more colloquial **language**, synergetics investigates "the ways things work together".

H. HAKEN explains: "By their **interactions** with each other, these **subsystems** may produce spatial, temporal or functional **structures** via **self-organization**. Synergetics seeks for general principles underlying these **processes**, where it focusses its attention on those situations where **self-organization** sets in, i.e. where new qualitative features of a **complex system** emerge. Basic concepts ... are **stability** and **instability**, **order parameters**, the **slaving principle**, **critical fluctuations**, for-

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

mation of spatial or temporal **patterns, chaotic states**. The fields these methods have been applied to comprise physics, chemistry, biology, computer sciences, sociology, economy, physiology, and psychology" (ibid).

HAKEN distinguishes three different methods used by synergetics, depending on the kind of tasks:

"a) *The microscopic approach*. In it is assumed that the individual **variables** of the **subsystems** and the **laws** for their temporal **evolution** are known. Then, close to **instability** points, when new **patterns** emerge, the theory shows that the dynamics of the whole system is governed by a few **variables**, the so-called **order parameters**, which enslave the **subsystems**. This approach is also valid in the mesoscopic case, e.g. in fluid motion, where again the basic equations are known though not for the molecules explicitly, but for the volume **elements**.

"b) *The macroscopic approach based on the maximum information (entropy) principle*. In this approach it becomes possible to determine the **distribution function** of a system **far-from-equilibrium** by means of special moments, or the determination of Fokker-Planck equation, starting from specific correlation **functions**.

"c) *The phenomenological approach*. If the microscopic of meso-dynamic **laws** are not known, one may nevertheless try to describe a system by means of adequate macroscopic quantities, namely the **order parameters**" (ibid, p.1016).

The study of processes like **autogenesis, self-catalysis, self-organization** and **auto-poiesis** is central in synergetics.

In a recent paper Elena KNYAZEVA (Russian Academy of Sciences) argues that "Synergetics is a mental scheme or a **heuristic approach** to exploring the complex **behavior** of systems, rather than a universal key to solving concrete scientific problems" (2003, p. 53)

She adds: "Synergetics does not invent speculatively general evolutionary laws, it discovers them and put **boundary conditions** on their application. To use synergetic **models** is likely to get into the inner **mechanisms** of **evolution** and **self organization** of **complexity** in nature" (p. 54)

Synergetics studies are led at the Russian Academy of Sciences within the Keldysh Institute of Applied Mathematics (Prof. S.P. KURDYUMOV) and the Institute of Mathematical Modelling (Prof.A.A. SAMERSKII)

E. Knyazeva signals the following developments in synergetics that take place at the Academy:

1- the investigation of mechanisms of **localization** of **processes** and the formation of **structures** in open **nonlinear media**

2- the idea of discrete spectra of dissipative structures-**attractors** in open nonlinear media

3- investigation of very fast developing processes and their self-strengthening in open nonlinear-media (blow-up **regimes**)

4- studies in the principles of **integration** and construction of complex structures, including the exploration of ways of **co-evolution**

5- the principles of non-linear **management**.

The author also connects PRIGOGINE's works with synergetics, as well as the basic model of **self-organized criticality** (the sandpile model) (ibid)

The transdisciplinary character of synergetics is becoming evermore evident.

3309

SYNERGISTIC SELECTION ²⁾⁴⁾

Positive selection produced through a trend towards **cooperation** among **clustering elements**.

This notion has been introduced by J. MAYNARD SMITH in his paper on "The Evolution of social behavior" (1982, p. 28-44) and developed by him and E. SZATHMARY in subsequent papers.

It is to be noted that the concept of "advantage through **altruism**"-a **value**-laden concept - has been progressively abandoned by MAYNARD SMITH and others and replaced by the more neutral (and measurable) one of **cooperation**.

It could even be argued that cooperation is probably in itself a result of a primarily accidental **association** which produced a common **reinforcement of fitness** in some specific **environment** and/or circumstance.

P. CORNING produced a handy **synthesis** on the subject (1998b., p. 25-26)

→ **Kin Selection; Symbiogenesis**

3310

SYNERGY PARADIGM ¹⁾²⁾³⁾

The use of the synergy concept to explore all kinds of **relationships**, as proposed by P. CORNING (1998b, p. 27-28)

CORNING writes: "What are the implications of a "synergy paradigm?" First, it could serve as a lingua franca for the cooperative/emergent/interactional **effects** that are observed and studied by various disciplines. By removing a **language** barrier, the term could facilitate **cross-disciplinary communication** and **understanding**.

" Second, by directing our attention to **context-specific "historical" relationships** and **interactions**, rather than "**mechanisms**" or **reductionist "laws"**, the synergy paradigm encourages a multi-leveled, **multi-disciplinary** research and theory that is free from the intellectual shackles of 19th century Newtonian physics. Furthermore, the synergy **paradigm** draws our attention to the functional aspect of cooperative **effects**. As noted earlier, concepts with broad applicability to many different kinds

of **phenomena** may play an important theoretical role in the sciences. The synergy concept provides a **framework** for integrating the research in various disciplines that may be relevant for understanding the broader causal **role** of **cooperative phenomena** in nature and **evolution**. To borrow the "pre-owned" parable of the blind men and the elephant, if we are ultimately to make sense of the **whole**, we will need to pool our discoveries about both the **parts** and the whole.

"All scientific concepts are inescapably Pro-custean and selective, highlighting certain aspects of the phenomenal world to the exclusion of others. None can be all things to all scientists. The ultimate test is fruitfulness. By the standard, the concept of synergy would seem to hold promise. Among other things, it offers a theoretical **framework** which, like the concept of natural **selection**, can provide a focus for explaining a major aspect of the evolutionary **process**, namely, the evolution of organized **complexity**. Indeed, an invigorated science of synergy would shine a spotlight on a fundamental property of the **phenomenal** world. Equally important, because it is pan-disciplinary (and egalitarian) in its **methodological** implications, the concept of synergy could provide a useful bridge between various specialized disciplines. If synergy can provide functional advantages elsewhere in the phenomenal world, why not also within the scientific enterprise itself". (ibid)

3311

SYNERGY

"The action of two or more substances, **organs** or **organisms** to achieve an effect of which each is individually incapable" (The American Heritage Dictionary).

Another definition, by Ch. HAMPDEN-TURNER, as quoted by N.A. COULTER Jr. reads: "Synergy is the fusion between different aims and **resources** to create *more* between the interacting parties than they had prior to the **interactions**" (1979, p.26).

COULTER also gives his own definition: "... any property of a system that promotes two or more **functions, processes, goals**, etc., while impeding none" (ibid).

COULTER observes that synergic power transcends **hierarchic** directive power, specially in **organizations** where it fosters: "...the ability to engage others in joint efforts to increase the satisfaction of all" (ibid., p.27).

According to BECKMINSTER FULLER, (as quoted by O. JOHANSEN BERTOGLIO): "An **object** shows synergy when, examining one of various of its **parts** (or even each and everyone of them) separately, it is impossible to explain or predict the **whole's behavior**" (1985).

In this case, we call it a system, in view of the new global **behavior** resulting from the **interactions** among the **parts** or **components**.

L. KOHOUT and B. GAINES state: "The synergies increase the speed of reaction of the **organism** as well as decrease demands on **information**-processing capacity during the **synthesis** of a particular action or movement."

They extend soon this view to computing **processes**, where, according to them synergies appear as: "... **subroutines**, ready as **whole** units to be triggered off in an appropriate **situation**" (1976, p.17).

Curiously however, synergy implies at times that **parts**, in order to become synergic, must partly relinquish some aspects of their own **behavioral patterns**.

In the recent years, (1983 to day) P. CORNING has deepened the study of synergy as a fundamental systemic **phenomenon** of a typically **transdisciplinary** character. He emphasized its very general nature as "the subset of all imaginable **interactions** that have combined functional **effects** (positive or negative) and added: "Synergistic **causation** is **configurational**: synergistic **effects** are always co-determined" (1998b, p.8-10).

And finally: "Synergy is real. Its effects are measurable and quantifiable: e.g. economies of

scale, increased **efficiency**, reduced **costs**, higher **yields**, lower mortality **rates**, a larger number of viable offsprings, etc... More subtle measuring rods include enhanced **stability** properties, greater **stress tolerance**, increased fidelity in **reproduction**, the melding of functional **complementarities** to achieve new properties, and so forth" (Ibid, p.12).

CORNING advocates for a "Science of **Relationships**", whose main research tool would be a "**synergy paradigm**" (see hereafter).

CORNING produced the following table of **synergistic effects** in a selection of scientific disciplines (Ibid, p.8):

see table below

For complementary information, see reference 1998b.

3312

SYNTACTIC NOISE³⁾

"Any **structural** difference between a **message** sent and the **message** received" (R.L. ACKOFF & F.E. EMERY, 1972, p.182).

These authors, who introduce the notion, make a curious comment: "Even if a **message** is not changed structurally, it may not be received (that is, interpreted or decoded) as it was sent. What is intended as a compliment by A may be interpreted as an insult by B: "You look so much younger than you are" (Ibid).

Is this not stretching the notion too much?

3313

SYNTACTICAL REDUNDANCY²⁾ - 3)

The fraction of a **message** that is unnecessary if no **noise** must be overcome.

Syntactical redundancy is related to the **knowledge** the **receiver** has of the **code** used. For example, in the word "quite" the letter "u" could be generally omitted, because it is well known by English-speaking persons that the letter "q" is always followed by the letter "u".

3314

SYNTACTICS¹⁾ - 3)

The branch of **semiotics** that deals with the properties of **signs** and **symbols** and with their formal **relations**.

Correct syntactics is the condition of a transparent use of any **language**. It implies proper coordination between all the **rules** characteristic of the **language**, and thus its global **structure**.

GERNERT (2000 a, p. 155) comments: "Syntactic **information** is the alteration produced by incoming **signals** in the heads of telecommunication engineers who are waiting at the end of the **channel** and value the finished **transmission** under the aspects of their profession, e.g. **channel capacity**, **efficiency**, or **reliability**" (p. 160)

This seems to be basically a technical viewpoint, bearing upon **communication** under SHANNON's original **meaning**.

GERNERT himself made the point (his 2000 b) paper), quoted in the entry "**Information theory**")

Even so, syntactics seems to include two **codings**:

1) an electro-magnetic one through which a specific electro-magnetic signal corresponds to a specific **sign**

2) a sign (for example, a spoken word) corresponding to a shared **code** between a sender and a receiver, let us say for example "pencil" in a telephone conversation (What is the meaning of "Bleistift" for someone who does not know german?)

3315

SYNTAX¹⁾ - 3)

"The rules by which **symbols** can be concatenated to form legitime strings" (H.von FOERSTER, 1981, p.217)

Table: see entry SYNERGY

Discipline	Representative Examples	Associated Terminology
Quantum physics	Quantum Coherence	Holism , ordering
Physics	Chaotic Phenomena	Emergence , interactions , attractors , order
	Self-organized critically	Interactions , holism
	Phase transitions braking	Cooperative effects , symmetry
Thermodynamics	Dissipative structures	Order/disorder low entropy , negative entropy , order , emergence
Biophysics	Hypercycles	Cooperation , interactions , Coordination , order , emergence
Chemistry	Molecular macrostructures	Symmetry , collective stability , order
Biochemistry	Supramolecules	Interaction functional integration Coordination
Molecular Biology DNA	DNA	Complementarity , epistasis , heterosis
Developmental Biology	Homeobox Homeotic genes	Organization , cooperation , coordination
Neurobiology	Neuronal transmission	Cooperativity, thresholds effects , emergence
Ecology and parasitism Behavioral Biology	Coevolution	Interactions , mutualism
	Symbiosis	Mutualism , cooperation
	Sociobiology	Mutualism reciprocal altruism , emergence , cooperation , division of Labor

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Such **rules** form an interconnected and interactive **set** and **structures** any type of **language** or **signs** system.

However, as argued by J. SEARLE, "no amount of syntax alone (i.e. **symbol** shuffling) can ever give rise to **semantics**" (Quoted by J. CASTI, who adds the comment that the classical **symbol** shuffling computer "can have no understanding of the *meaning* of the **symbols** it manipulates" (1994, p.163).

von FOERSTER observes: "... **semantics**, i.e., the **rules** that give **meaning** to those strings, was long a dirty word. This is not so any longer after it has been recognized that syntactic ambiguities are disambiguated in the **semantic domain**" (Ibid).

Semantics is thus at the **metalevel of validation** for syntactic constructions. This should be obvious, as it is perfectly possible to construct non-sensical strings of **symbols** without any violation of syntactic **rules** ("The dog burns the silken palmtree"), or even that such strings become meaningful only if and when the **receiver** knows the **semantic frame** in which they make sense. ("Mtoto alivunjika sahani"... a perfectly significant sentence in Kiswahili).

3316

SYNTEGRITY

The combination of **synergy** and **integrity** resulting from all the possible **interactions** of a number of participants.

The **concept** of **syntegrity** has been introduced by S. BEER (1994). It is derived from BUCKMINSTER FULLER's **tensegrity** and BEER applies it to the exploration of some topics by a group of 30 people (See "Team Syntegrity")

The basic **model** is the icosahedron, with its external and internal **connections** (1994, p.284-5) whose graphical **representation** shows all the possible **interrelations** among the participants.

3317

SYNTHESIS (Systemic methodologies of) ¹⁾

The achievement of a satisfying global vision of a system involves a difficult methodological problem: **Synthesis**. In spite of its importance it did not worry too many systemists up till now, except J.L. LE MOIGNE ("Theorie du système général", 1990a) and R. RODRIGUEZ DELGADO (1993b) This last author distinguishes the following different ways toward synthesis:

"- **Structural synthesis**: Once **structures** have been analyzed and well known they should allow for a global and renewed **representation** of the system.

"- **Functional synthesis**: the same **structures** may lead to various functional **distributions**, which should be optimized. **Synthesis** and **generalization methods** allow for the global study of **functions** and the shaping of functional **models** which will permit to select some convenient ones.

"- **Relational synthesis**: synthesis and generalization **methods** also may be used for the shaping of **models** of the systems internal and external **relations** and of criteria allowing for the best adapted **choices** respect to the problem or the **situation** as it is.

"- **Historical synthesis** : historical synthesis studies allow for a global view of the system **development** in **time** and for predictions which would not be possible by other techniques.

"- **Interdisciplinary synthesis**: which takes place when two or more disciplines formerly isolated become united as for example: Physico-Chemistry, Biochemistry, Sociocybernetics, or **Ecology**.

"- **Prospective synthesis**: by use of **feed-forward techniques** it becomes possible to better **short-term predictability** and to establish probable **medium** and **long term scenarios**.

"Synthesis techniques vary widely according to the **class** of systems to which they are applied" (1993b, p.293-4).

One may also think that the various synthesis **methodologies** are in every case depending on specific systemic concepts.

For example:

- Structural and functional synthesis should be grounded on a common **taxonomy of subsystems** (MILLER, 1978) and on the concept of **synchronic-diachronic structure**.
- Relational synthesis should use **interconnections graphs** and anew the **taxonomy of subsystems**, as well as the concept of **interface**.
- Historical synthesis does not seem yet to have found its own systemic and cybernetical **models**. The concept of **limit cycle** and those of **morphogenesis**, **steady state** and **ageing** would probably be useful.
- Interdisciplinary synthesis involves finding new **objects** for research which could be modeled as **complex systems** as for example cyclical **catalytic** reactions, synaptic **connections** in neural **networks**, **autopoietic organizations** or biotopes.
- **Prospective** synthesis depends upon skilled use of the concepts of **bifurcation**, **catastrophe**, and combined **cyclical rhythms**, among others.

3318

SYNTONY ^{1) - 2) - 4)}

The collective **behavior** resulting of reciprocal **entrainment**.

Syntony can be considered as a weaker form of **synchronization**. It is produced through the reciprocal **perception** by the **elements** of their more or less regular **behavior**. It is a **phenomenon** of **resonance**.

Syntony is present in many biological and physiological **phenomena**, as well as in social ones. The **emergence of paradigms**, or in German the "Zeitgeist" or the "Gleichschaltung" are cases of cultural syntony, traduced in shared beliefs.

In **Evolutionary Learning communities (ELC)**, a more open understanding of syntony emerges. K. BAUSCH describes it as follows:

"Conscious intention aligned with evolutionary **purpose**; more loosely, the embodiment and manifestation of conscious **evolution**; a purposeful creative aligning and tying with the evolutionary **flows** of one's **milieu**" (Glossary, Pers. comm., 2002)

3319

SYNTONY QUEST ¹⁾⁴⁾

Alex and Kathia LASZLO have adapted the **concept** of syntony to **human systems**. Syntony Quest is about seeking "to catalyse **learning processes** that empower individuals and **groups** to develop the competencies necessary for the co-creation of **sustainable**, evolutionary futures"

Essentially, they propose:

- transformative **learning**
- the **design** of self-directed learning processes
- the acquisition of evolutionary **competence**
- the conscious creation of **sustainability**

They base these proposals on the following areas of **knowledge**:

- **evolutionary systems theory**
- social systems **design methodology**
- transformative learning philosophy

They consider that "these approaches lead to the mastery of the **knowledge**, abilities, **attitudes**, and **values** required for co-evolutionary **action**, and thereby, for the pursuit of sustainable modes of being.

Syntony Quest is an **organization** (based in San Francisco, e-mail: **Syntony.Quest@usa.net**) "dedicated to the **development** of evolutionary **competence**" that seeks "to foster the **emergence** of **evolutionary learning communities** (ELCs) and communities of ELCs, i.e. evolutionary learning **ecosystems**"

Such ecosystems obviously included human active participation. The ELC concept has been mainly developpe by A. Laszlo himself (partly during **Fuschl Conversations**)

3320

SYNTROPY ²⁾

"The process of **negentropy** importation" (K. BAUSCH, glossary, Pers. comm., 2002)

BAUSCH adds: "a syntropic system is a **dissipative structure**" (ibid)

So called negentropy can be imported into the system as **energy inputs** or as already organized **matter** (food for ex. or pure iron, refined from iron ore)

Dissipative structuration is more readily associated with inputs of energy that is used by the system to maintain existing **structures**, or create new ones in case of excess of energy inputs.

→ **Emergence; Energy Entropy; Entropy production (Theorem of minimum); System (far from equilibrium)**

3321

SYSTEEM GROEP NEDERLAND ¹⁾

or Dutch Systems Group.

The Systeem Groep Nederland is one of the oldest Systems Society in existence. It "supports and promotes professional interests and ideas on the subject and serves as a base for the exchange and distribution of the results of research".

The S.G.N. publishes the Journal "Systemica" since 1980. It also organizes international conferences on generally quite original thematics related to cybernetics and systemics as for example: "Knowledge (dis)emergence", "Mutual uses of Cybernetics and Science", or "Problems of (Im)Possible Worlds".

The S.G.N. has been one of the three original founders of the **International Federation for Systems Research** and took charge for some quite critical years of the publication of "Systems Research", the Federation's Journal.

3322

SYSTEM ¹⁾

Very numerous definitions have been given of the word and the concept even if limited to G.S. Theory and Cybernetics, the differences between these definitions are striking. However, comparisons do not destroy the notion. On the contrary, many interesting shades appear.

Accordingly, we give hereafter many definitions, obtained from authors of different countries and specializations. As much as possible, they are supported by comments of the authors themselves. In some cases a critical **evaluation** or comment has been added.

The general idea is to extensively explore the multiple aspects of the notion in a non-contradictory way.

To put things into perspective here is G. WEINBERG's one: "The system is a point of view". And, similarly, for G. PASK it is a "universe of discourse" (predefined by a **reference frame**) (1961, p.22-3).

So "System" corresponds to a man-created general conceptual **model** for coherent, complex and more or less identifiable and permanently observed real world entities.

All definitions are more or less complementary. Some are more embracing than others and others more specific. All in all, this is one of the most evident case of **polysemy in language** and it would not be satisfactory to reject any off-hand without a careful scrutiny.

It should however be noted that no "point of view" and no "**universe** of discourse" on systems could exist without the simultaneous existence of something on which these subtle arts can be practised and which is generally called "**concrete system**", or perhaps more imprudently "real" system.

As a result, the most simple and synthetical definitions open the way to careless generalizations and simplifications.

The most elaborated can be limitative, for example, be valid only for **living systems**.

Furthermore there are *various* degrees of systemic **organization**, from the least **integrated** (composite or distributed systems) to the most differentiated and **integrated** ones.

Shortly, there is no perfect definition... and, again, many possible ones according to the "point of view".

Accordingly, we will thus give a number of them, first general, next more specific, in every case with the needed comments (from the authors or from this compiler, according to necessity). Most definitions are from genuine systemists or cyberneticians, and some more from other scientists or philosophers, because they seemed relevant.

In conclusion, a critical **synthesis** will be proposed, even as the conclusions are by no means to be taken as definitive.

Definitions

- "A system is a **set of elements** dynamically **interacting** and **organized** in relation to a **goal**" (J.de ROSNAY, 1990, p.93).

J.de ROSNAY comment is as follows: "The introduction of finality (the **goal** of the system) in this definition may seem surprising. Understandably, the **finality** of a **machine** has been defined and specified by man, but what dare we say about the **finality** of a system like a **cell**? The cell's "**goal**" is in no way mysterious. It implies no project. It is registered *a posteriori*: to maintain its **structure** and to divide itself. The same can be said about the **ecosystem**. Its **finality** – again, not project – is to maintain its **equilibria** and to allow life's development. Nobody did established atmosphere's content of oxygen, nor the earth's average temperature, nor the composition of oceans. Nevertheless, they maintain themselves within very narrow **limits**.

"This definition steps back from another with a certain **structuralist** overtone, for which a system is a **closed structure**. Such **structure** cannot evolve, but undergoes **collapses** due to some internal **desequilibrium**" (ibid).

"A set of **parts** with a common destiny, which maintain their **interrelations**, even when placed in a different **environment**" (F. BON-SACK, 1990, p.67).

The author comments: "In a system, there is first an object: a certain **connexity** in **space**, a conservation of internal **relations** at the **time** of a displacement entailing a **change** in the relations with the **environment**..."

"But there is more to it.

"There exists a **functional** unity. This means, a **whole** apt to perform some tasks and which needs the **functional** integrity of all of its **parts** in order to maintain that capacity..."

"...a car (for example) performs correctly its **function** – which is to guarantee quick, safe and comfortable travelling at whatever hour and practically any weather conditions – only if all **parts** correctly perform their respective **function**" (p.67).

"A **set** of interrelated **elements**" (BERTALANFFY, 1956 – ACKOFF, 1972).

This sweeping and embracing general definition is thus explained by R.L. ACKOFF: "... a system is an **entity** which is composed of at least two **elements** and a relation that holds between each of its **elements** and at least one other **element** in the **set**. Each of a system's **elements** is connected to every other **element**, directly or indirectly. Furthermore, no **subset** of elements is unrelated to any other **subset**" (ibid).

This definition does not allow a clear **distinction** between logical or **formal systems**, for example, and dynamic **concrete systems**. Nor is the role of the **observer** in any way expressed.

"... any **set** of **variables** that (the **observer** or experimenter) selects from those available on the real "**machine**" (W.R. ASHBY, 1960, p.16).

One very important feature of this definition is the emphasis upon the role of the **observer** or experimenter, who is supposed to "select" the **variables**, and whose intervention implies clearly that, in ASHBY's opinion, any system is a mere **constructed model**. Of course, some **criteria** would be needed, in order to avoid radical arbitrariness in the **process** of selection. A **criterion** should be, for instance, *coherence*, in relation to some general types of **interconnections** present in all **systemic-cybernetic models**. One should also note that ASHBY postulates the existence of the real "**machine**", an **object** "out there", which may very well be differently modeled by different **observers**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Finally, one could regret the use of the word "**machine**", a practice of the first cyberneticians which has been sharply criticized for its **mechanicists** undertones.

"A grouping of interrelated **elements** possessing a **boundary** and functional unity" (Ch. DECHERT, 1968, p.119).

DECHERT writes: "Each of the **elements** of a system is related, directly or indirectly, to all other **elements** so that a **change** in any **element**, to a greater or lesser degree changes the entire system. A system is distinguished from an **aggregate** (or **congeries**) by the inter-relatedness of its **elements**" (Ibid).

In this sense, a system is basically a **network**.

"A system is an **organization** comprising man and **machine components** b) engaged in coordinated **goal-directed activity**, c) linked by **information channels**, and d) influenced by an external **environment**." (D. HOWLAND, 1963, p.227).

This definition is only adequate for **human systems**, which, furthermore do not necessary include **machines** and whose activities are not always, at least consciously, **goal-directed**.

D. Mc NEIL deplors that: "The word **system** became cheapened by its identification with particular technologies such as computers or with particular **methods** such as "**systems analysis**" (1993 a).

He tries, in a recent and intricate definition, to include the many different aspects of systemic **organization**: "A system is a **dynamic**, organized, delimited, **open**, persistent, **composite whole**. It is **voluntary**, comprised of at least one **loop** and at least one **link** which manifest the aspects of **content**, **form**, **function**, and **control**, together with **timing** and **scaling** factors, relative to an **environment** and relevant to a percipient" (1993a). ("Percipient" stays here for "**observer**", as considered in this encyclopedia).

M. BUNGE gives a very synthetic definition which implies many specific features of systems, save their **relationships** with their **environment** (including how an "**object**" becomes defined): "A system is a complex **object** every part of which is related to some other **component** of the same **object**" (1993, p.211).

However Mc NEIL's definition reflects better the multi-facetic character of the "system"... and the need to ponder each and every characteristic stated in it.

There are numerous more specific definitions of peculiar **classes** of systems, most of which are reproduced – and commented, in view that some seem debatable – hereafter.

To conclude, systems are most generally characterized by their complexity, their **coherence** and relative permanence, and their tendency to seek their own **survival**. These general conditions dominate the whole concept.

3323

SYSTEM (Abstract) ¹⁾ – 2)

A system "all whose **elements** are **concepts**" (R.L. ACKOFF, 1972)

M. BUNGE calls this type of systems "conceptual systems" (1993, p. 211).

ACKOFF comments: "**Languages**, philosophical systems, and number systems are examples. **Numbers** are concepts but the **symbols** that represent them, **numerals**, are physical things... The use of different numerals to represent the same numbers does not change the nature of the system.

"In an abstract system the **elements** are created by defining and the **relationship** between them are created by assumptions (e.g. axioms and postulates) Such systems, therefore, are the subject of study of the so-called formal sciences" (Ibid).

G. KLIR states: "The **isomorphic transformation** from an interpreted system into the corresponding **general system**, which may be called an **abstraction**, is always possible. The inverse **transformation**, which may be called an **interpretation**, is not guaranteed and must be properly justified in each case. Indeed, relations among things based upon **distinctions** made in the real world cannot be arbitrary, but must reflect genuine **constraints** of the real world, as represented in our world of experiences. Hence, each interpreted system determines uniquely its representative **general systems**, by the **isomorphic transformation**, but not the other way around" (1991, p.17).

D. Mc NEIL observes: "... while a system may be represented by static **symbols**, e.g. in a "system" of musical notation, the formalism is only a **representation** of the **structure** of the system and that the system-ness itself is in the **dynamic** application of its **structure**" (1993 b). This is the difference between the score of a symphony and the symphony itself, when performed.

3324

SYSTEM (Adaptive) ¹⁾

Any system able to shift from one internal **state** to another as a **response** to **variations** in its **environment**.

It would be very difficult to conceive a **living** or a **social system** that should not be adaptive, at least respect to a **variety** of **changes** relevant to its **survival**.

R.L. ACKOFF writes: "A system is adaptive if, when there is a **change** in its **environmental** and/or internal **state** which reduces its **efficiency** in pursuing one or more of its **goals** which define its **function(s)**, it reacts or responds by changing its own **state** and/or that of its **environment** so as to increase its **efficiency** with respect to that **goal** or **goals**" (1972).

According to W. BUCKLEY, an adaptive system must be able to perceive **variety** and **constraints** in its **environment**, and to adjust its internal **organization** accordingly (1974).

It must necessarily have sufficient internal **variety** in order to shift from one adapted **state** to another, when needed. Furthermore, it must possess an **array** of **positive** and **negative parameters** defined **feedbacks**, that will allow it to respond to a definite **range** of **disturbances**.

Living systems in general, are more or less adaptive: Among them animal societies and **populations**; human individuals and **socio-cultural systems**.

An interesting bibliography on adaptive systems is given by G. KLIR (1991, p.161).

J. HOLLAND developed a generalized and formalized model of the adaptive system (1992, p.20;24;28)

3325

SYSTEM (Allopoietic) ¹⁾

Any systems "whose **organization** is such that it does not produce the **components** and **processes** which realize them as unities" (F.G. VAR-ELA; H.R. MATURANA & R. URIBE, 1991, p.561).

Man-constructed systems are allopoietic (at least until now).

The authors explain: "The actual realization of these systems, therefore, is determined by **processes** which do not enter in their **organization**".

Furthermore: "Allopoietic systems are by constitution non-**autonomous** insofar as their realization and permanence as unities are not related to their **operation**" (Ibid).

Such systems must be **started**. However, once functioning, and the existence of their allopoietic conditions guaranteed, they seem to possess at least some degree of **autonomy**, specially if they are equipped with internal **regulators**.

→ **Allopoiesis**

3326

SYSTEM (Almost homogenous)

→ **System (Composite)**

3327

SYSTEM (Almost isolated) ¹⁾

Any system which presents the two following characteristics:

1) It is influenced by the outside world, but only through certain defined **processes**, called **inputs**;

2) it exerts an influence on the external world, but only through certain defined **processes** called **outputs** (adapted from H. GRE-NIEWSKI, 1989).

This definition, by GRENIEWSKI and quoted by J.L.LE MOIGNE is reproduced here merely for information. An "almost **"isolated system"** is clearly a "somewhat open" one (as appears from the definition itself) and as such, open or closed in **space** and **time** for specific **inputs** and **outputs**. Thus, while the described characteristic are in effect very general, it would be better to avoid GRENIEWSKI's terminology in this case.

3328

SYSTEM and Environment ¹⁾

1. Any system appears as a discernable entity within its surroundings. This **entity** is endowed with a defined **identity** and a relative permanence.
2. To any system corresponds a significant environment, which is that **part** of the **universe** with which the system has occasional or frequent and characteristic exchanges.
3. The system possesses a **membrane** or **boundary**, permeable in a selective way, composed of **elements** that are able to interact with certain types of **elements** in the environment and also with some specific internal **elements**. This means that the **boundary** is an **interface**.
4. The system obtains from its environment whatever **inputs** it needs for its construction and **maintenance**.
5. The system devolves to its environment the specific products of its activity, transformed or degraded **energy**, re-elaborated **information**, but also **wastes** and **noise**.
6. The system and its environment, through their **interactions**, undergo reciprocal **transformations**.
7. When the system finally disappears, its **elements** recover their **independence** and scatter within the environment or become incorporated in other systems. However, quite frequently some trace or record of the system remains for a more or less long period. (See **"Aura"**).

3329

SYSTEM (Anticipatory) ^{1) - 4)}

A "system that possesses on-going capabilities of building relevant systems **models** of its **environment** and is able to use these **models** for making **decisions** and **actions** that optimize specific **goals**" (Adapted from G. KLIR, 1991, p.190).

Thus: "This means that an on-going systems **modeling** of relevant aspects of the **environment** will be an essential feature of the **decision-making infrastructure** of **organizations**. This implies that expertise in systems science will be in increasing demand by **organizations** in the **information society**" (Ibid).

R. ROSEN observes that "the essence of anticipatory **behavior**... involves the **concept** of **feedforward**, rather than **feedback**". Indeed: "the essence of **feedback control** is that it is *error-actuated*; in other words the **stimulus** to corrective **action** is the discrepancy between the system's actual present **state** and the **state** the system should be in. Stated otherwise, a **feedback control** system must already be departing from its nominal **behavior** before **control** begins to be exercised".

As to the **feedforward** system, its basic condition is: "that present **change** of **state** is determined by an anticipated future **state**, computed in accordance with some **internal model** of the world" (1979, p.183).

This is different of, but consonant with the CONANT-ASHBY idea that "Every good **regulator** of a system must be a **model** of that system": Such a **model** is needed for the system to be able to make more or less reliable **predictions** about its own future when confronted with external (or internal) **disturbances**. It is of course necessarily based on registered past experiences and their outcomes. There is thus no **time paradox** in the concept of **anticipatory behavior**.

3330

SYSTEM (Appreciative)

→ Appreciative System

3331

SYSTEM (Anticipatory)

→ Anticipatory system

3332

SYSTEM (Appreciative) ²⁾

The outside system as it is interpreted by the **observers** through mental **images** according to the **"Weltanschauung"** (worldview) of these observers.

According to G. VICKERS the appreciative systems are cut starting from our expectations and evaluated through our **standards** and **criteria**

→ **Model; Modeller; Modelization; Objectivity; Observer; World models**

3333

SYSTEM as a NETWORK (The) ^{1) - 2)}

According to CH. DECHERT: "Natural systems such as **communities** or **ecological** systems may perhaps be reduced to the resultant of probabilistic **interaction** on the basis of the **behavioral programs** inherent in each **component**" (1968, p. 119).

It would seem that we need to bridge the gap between individual **behavior** and global one by something more than probabilistic **interactions**. At least, these last would have to be somehow stabilized through **rules** of inter-

action. Such **rules** may be intrinsic because the **components** characteristics allow for some **interrelations** and exclude others. The thus defined **constraints** establish the future **autopoietic** nature of the system (see for example von FOERSTER **magnets experiment**).

In the same vein, **cellular automata** are constructed from standard **elements** evolving within a characterized **space**, through defined **rules**.

DECHERT observes: "In artifactual systems, the principle of **integration** is either external, or insofar as such systems are **self-regulating** or **self-organizing**, internal and localized" (Ibid).

A system self-generated as a **network** should be **first self-organizing** and later on **self-regulating**: i.e. it constructs its own internal **determinism**, by progressive reciprocal **emergence** of self-generated **constraints**.

3334

SYSTEM (Autonomous) ¹⁾

"A system whose **action** results of its own impulses, which selects its **goals** and the means to pursue them according to its **knowledge** of the **laws** of the world and its present **perception**" (F. BONSACK, 1990, p.118).

There are various **understandings** of what autonomy means; for a general survey, see: **Autonomy**.

F. BONSACK adds: "The source of **actions** is not however immune to any **feedback** from the world,... but these **inputs** should not be considered as the source of **action**: they only modulate the internal source" (Ibid.).

This is the basic **meaning** of the concept of **autopoiesis**.

R. ROSEN states: "It is absolutely essential... that the **time-dependent inputs**, or forcings, do not change the autonomous **dynamics** in any way. it must neither create nor violate the system **constraints**; more generally, it must not change any of the **parameters** which govern both transient and **asymptotic behaviors** in the autonomous system... This restriction is not often mentioned explicitly, but it is absolutely basic. Unless we impose it, the very **identity** of the system will depend on the **environment** with which it is interacting, i.e. the **identity** of the system *in vacuo* will be different from what it is in a specific **context** which is forcing it, that **identity** has become, in a sense, **context-dependent**" (1993, p.21).

3335

SYSTEM (Autopoietic)

→ Autopoietic system

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3336

SYSTEM (Behavior)^{1) - 2)}

"A *behavior system* is defined by a **time**-invariant relation among selected present, past, or future **states** of the **variables** in the experimental **frame**" (G. KLIR, 1988, p.151).

KLIR comments: "... The **states** are selected by a **mask** through which we observe given **activity** and take samples corresponding to different **time** instants" (1988, p.151).

This implies that, for some **purpose**, we focus our attention onto some type(s) of behavior, possibly or even probably ignoring others.

3337

SYSTEM (Chaotic)

→ Chaotic System

3338

SYSTEM (Closed)²⁾

A system able to absorb and emit **energy** and **information**, but not **matter**.

This definition is generally accepted.

Notwithstanding, the concept of closed system is one of the most semantically dubious in **systemics**.

To begin with, it should clearly be distinguished from the *isolated system* concept, with which it has been sometimes confused. Indeed, the **isolated system** does not absorb or emit anything... and, as a result, cannot be perceived by any **observer**.

It has been also been written by some authors that the closed system exchanges only **energy** with its **environment**, excluding **matter** and **information**. It is quite difficult to imagine a *concrete system* that would offer such a curious characteristic.

Organizationally (or **operationally**) closed systems are also frequently considered closed in this sense, being then defined as a **set of relations** between **components**, such that states **transitions** of the system are **state determined** (H. MATURANA, 1975). However, **concrete systems** that maintain their internal **organization** are able to do that even when they exchange **matter** and, or **information** with their **environment**. Only that some exchanges are admissible and others are not. Obviously "**closure**" does not mean insulation or isolation.

It could be argued that any satisfactory **model** of a **concrete system** must necessarily and simultaneously be open *and* closed, according to the functional requirements of the system. Thus we should speak only about closed (or open) systems specifying the **inputs** and **outputs** they admit or not, as well of the precise moments these are admitted or rejected.

N. GEORGESCU ROEGEN formulates the following basic law: "No closed system can perform mechanical work at a constant rate indefinitely" (1982, p.318). He notes that this **law**

"... is the twin of the **second law of thermodynamics**, which prohibits the endless derivation of mechanical work at a constant **rate** from a finite amount of free **energy**" (Ibid, p.321).

Another problem with the closed system **model** has been emphasized by G. BROEKSTRA (after G. SAGE): "The closed system **metaphor** was that of the **organization** as a **machine** or clockwork" (1992, p.1025). The presence of this **metaphor** in the minds of many business executives has undoubtedly provoked the demise of numerous enterprises. It has also been instrumental to the awful bureaucratization of many **organizations** at the administrative and governmental level. Indeed, when the clockwork is constructed, it is not supposed to be modified outside of its own basic **rules** and it becomes too perfectly "**autopoietic**", losing any adaptive capacity".

As noted by T. BAUMGARTNER et al, "... in general, the assumptions (or theory) underlying closed systems **models** and **methods** contradict the assumptions required (in practice) in a research **situation** involving **open systems**. Rarely, even under experimental conditions, do social scientists *achieve* the degree of **closure** (or **control**) which closed system **models** and **methods require**" (1976, p.39).

There is, furthermore, a **time frame** problem: "Indeed, social science **data** and analyses are often based on a **time span** of **observations** so short that the "open" nature of the system is not detectable, and **relationships** between and among **variables** appear stable" (Ibid).

And this is not only true in human systems, but also in **complex systems** in general.

3339

SYSTEM (Co-)^{1) - 2) - 4)}

Any system whose **activity** is closely coupled to the **activity** of the system under consideration.

In living beings, co-systemic **activity** may respond to **commensalism**, **mutualism**, **symbiosis** or **parasitism**.

The co-system differs from the **subsystem** as it maintains a clearly distinct **identity**.

By analogy, the concept can be extended to **human systems**: for example in economy, an enterprise is connected with many co-systems, as f. ex. suppliers, clients, labor unions, governmental offices, etc...

3340

SYSTEM (Colonial)^{1) - 2) - 4)}

A system that expands by creating new systems of its own kind in its **environment**.

In this sense the conservation of genetic **identity**, or in **human systems**, **language** and cultural **values** is paramount. The maintenance of a strong bond with the original system is also essential.

Many plants are colonial. One of the most interesting case is that of some originally individual poplar trees, which may finally occupy quite a wide area, through offshoots from far-reaching roots. Bracken (in England) is another example. The banyan tree is still another.

Animals do not seem to evolve in colonial systems, save some invertebrates as for example hydras.

In **human systems**, multinational enterprises, religious **organizations**, or the former colonial empires are examples of colonial systems.

3341

SYSTEM (Complex)^{1) - 2)}

"A system made up of a large number of **parts** that **interact** in a nonsimple way" (H. SIMON, 1965, p.63).

SIMON comments his definition as follows: "In such systems, the **whole** is more than the sum of the **parts**, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the **parts** and the **laws** of their **interactions**, it is not a trivial matter to infer the properties of the **whole**. In the face of **complexity**, an in-principle **reductionist** may be at the same time a pragmatic **holist**" (Ibid).

Thus, the two approaches are by no means exclusive. On the contrary, they should be considered complementary: the first one study the **parts**, **components** of **subsystems**, and the second one investigates the **interactions**.

As shown by SIMON in his "Architecture of **Complexity**" paper, this is by far the tallest order.

Another important point is made by R. ROSEN: "Simple systems do not make **errors**; it is meaningless to regard a system of mechanical particles as behaving erroneously. Therefore there has always been a relation between **complexity** and the capability for **error**" (1991, p.481).

This is consonant with the possibility of alternative **choices** and the need for **decision making**.

J.de ROSNAY describes the complex system in the following way:

- It is composed of a great **variety** of **components** or **elements**, which possess specialized **functions**.
- These **elements** are organized in internal **hierarchical levels**. (For example, in the human body: the **cells**, the **organs**, the systems of **organs**).
- The different **levels** and individual **elements** are connected by a great **variety** of **linkages**. As a result the **density** of the interconnections is very high.
- The **interactions** among the **elements**... are of a peculiar type. They are said to be *non-linear*" (1990, p.96).

This is merely a static **description** of any instant **state** of a complex system. From the **dynamics** viewpoint, as stated by P.M. ALLEN et al: "... complex systems involving **nonlinearities** and **feedback** may possess multiple solutions, and the **bifurcation** of a particular solution is a common **phenomenon**" (1984, p.152). And, at every possible **bifurcation**: "... the system can probe the "validity" of its own **state** of **organization**, and either retain it nevertheless (**stability**), or move away to some other branch of solution, some other **state** of **organization** and perhaps of **complexity**" (Ibid).

According to J.L.LE MOIGNE (1990), a complex system must offer the nine following characteristics: 1) be identifiable; 2) be active; 3) be **regulated**; 4) be informed about its own **behavior**; 5) decide its own **behavior**; 6) be able to memorize; 7) be able to coordinate its **decisions** taken for **action**; 8) be able to imagine and conceive new possible **decisions**; 9) be able to pursue **goals**.

R. ROSEN also offered methodological suggestions about the practical ways to study complex systems:

"a. The only way in which we know how to approach complex systems is to simplify or **abstract** them in some way;

"b. Such simplification amounts to splitting the system into **subsystems**, which are simple enough to be characterized in isolation, and such that our **knowledge** of the isolated **subsystems** can be effectively employed to give us **information** about the original system".

This "splitting", unfortunately, merely reflects DESCARTES old dream, because it eliminates the dynamical **interactions**.

ROSEN himself recognizes this immediately: "In biology, the **abstractions** offered by physical **reductionism** do not in general satisfy proposition b, in that they are not generally compatible with the **dynamics** of the original system" (1972, p.61-2).

For more see: "**Complex system**".

3342

SYSTEM (Composite) ^{1) - 2)}

An almost **homogeneous** system composed of weakly interacting or non-interacting numerous **elements**, similar or pertaining to a reduced number of **classes**.

Such systems should better be named para-systems or quasi-systems, because they lack a number of properties characteristic of more **integrated** systems, as for example:

- they have no definite **function**
- they have no **subsystems**
- they are not **autopoietic**, nor **autonomous**
- they are generally quite **homogeneous**

The **elements** of the composite system are merely in contact, but normally not connected or only weakly connected. Furthermore, its **behavior** is not really integrative and it is not **autonomous** in the **autopoietic** sense, as it is not able to reproduce its **elements**, nor the characteristic **interrelations** among them.

As a result, it must suffer the impacts from its **environment** in a mostly passive way.

However, it may present some characteristic global **states** or **behaviors**, as for example:

- **self organized criticality**
- **spatial self-similarity**
- **percolation processes**
- **runaway processes**.

Examples of composite systems are: heaps of sand, accumulations of snow on mountains, flowing fluids, stock markets, active geological zones, small ecological systems (as, for example, mono- or oligo-cultivation orchards or fields), and possibly star **clusters**.

In some former papers, P. BAK and collaborators used to denominate "dynamic systems", this class of systems which was not very satisfactory, because *all* classes of systems are dynamic.

In the above definition "**homogeneous**" means the opposite of "**heterogeneous**", which is a **state** of highly **complex** and **integrated systems** with many specific and different functional **parts**.

3343

SYSTEM (Conceptual or formal) ^{2) - 3)}

"A system all the **components** of which are concepts" (M. BUNGE, 1993, p.211)

R.L. ACKOFF calls this type of systems "**abstract systems**" (1972, P.84).

According to F. FRISCHKNECHT and J.P.van GIGCH: "Formal systems have three **levels**: vocabulary (terms), **language** (expressions) and system (**production**). Being **isomorphic**, **models** parallel formal systems: **code**, **semantic net** (**data base**), and algebraic **structures**. In the theory of computation, **levels** are called atoms, **frames**, and **states**. Formal systems are closed at both ends, by their primitive terms, and by the **syntax** of their logic" (1989, p.242).

The basic problem with all kinds of formal systems is that they are absolutely limited by the scope of their selected basic concepts. For example, **linear models**, which reflect **linear causal determinism**, are not apt for the interpretation of **nonlinear transformations**.

3344

SYSTEM (Concrete) ^{1) - 2) - 3)}

1a) "An **aggregate** of items that happen to be things (concrete items) and furthermore interrelated in such a way that the **relations** make some difference to the **components**" (M. BUNGE, 1974, p.235).

1b) A set of things, together with the **set** of **connections** among them" (p.229).

2) A system whose "at least two **elements** are **objects**" (R.L. ACKOFF, 1972).

BUNGE equates "concrete" with "material" (1993, p.212). He also writes: "... some of the relations among the **components** of a concrete system are **connections** or links, i.e. every **component** of the system acts on or is acted upon by some other **components** of the same system" (BUNGE, 1974, p.235).

He also states: "On the other hand, a set of **states** of a thing and a collection of **events**, even if ordered, are not concrete systems" (1979, p.7).

And an "... equally pervasive feature of concrete systems is that they react on their **environment**, i.e. that their **output** is never nil (The so-called **machines** without **output**, studied in **automata theory**, are of course fictions)" (1979, p.25).

Correspondingly: "All concrete systems are physical entities, in that they possess **energy** – a measure of changeability... However, some concrete systems are more than just physical entities, in the sense that the **categories** of physics are insufficient to account for them. For example, some are **social systems**" (p.45).

R.L. ACKOFF observes: "In concrete systems establishment of the existence and properties of **elements** and the nature of the relationships between them requires research with an empirical component in it. Such systems, therefore, are the subject of study of the so-called non-formal sciences" (Ibid).

3345

SYSTEM (Connectionist) ²⁾

"A system that contains no explicit **symbols** or **rules**" (J. SUTHERLAND, 1995, p.64).

The commonest kind "are known as **neural nets**" "They consist of **layers** of units, each **layer** connected to the rest at **random**. The first **layer** is triggered by an **input** and the last **layer** represents **output**. The intermediate **layer** or **layers** are called "hidden units". The connections between **layers** are triggered in **parallel**, and their strengths increased or decreased with successive **inputs**" (Ibid).

Two basic characteristics of connectionist systems are that:

- they construct their own **rules** according to successive **responses** to successive **inputs**.
- they are not totally impaired when locally damaged, but only slightly deteriorated.

The **brain** seems to be a connectionist system.

3346

SYSTEM (Conscious) ³⁾

Following A Harry KLOPF, to be conscious, a system must possess two characteristics:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

1. It must include a **model** of itself, of its **environment** and of the **relationship** between both
 2. The **information** included in the **model** must be encoded in terms of physical **variables** that are identical with the psychic **variables** we introspectively know (after KLOPF, 1972, p.35).

He adds: "Should the system's **information** be encoded in terms of some other **set** of physical **phenomena**, the system could *behave* as we do but not necessarily *feel* as we do. This is a way of observing that systems may be **isomorphic** with respect to their **behavior** and still differ with respect to their psychic existence" (Ibid, p.37).

One may wonder what precisely the author means by physical **variables** "identical" to psychic **variables** and, even, what is exactly a "psychic **variable**". However his hypothesis about the psychism of eventual non human conscious systems – as for example electronic ones – is arresting.

3347

SYSTEM (Conservative, or Hamiltonian, or non-dissipative) ²⁾

The ideal **model** for a conservative system is the pendulum devoid of friction, which in theory maintains an invariable movement and a constant **energy**.

This type of system may be represented by equations integrable without restrictions and its past and future **behavior** can be completely computed.

The theoretical simplification thus obtained is useful for the prediction of the **behavior** of those **concrete systems** whose **energy** is *nearly* constant and are controlled by only one **dominant variable**, as for example the planets in the solar system.

Perfect conservative systems (which do not exist in the real world), having a constant **energy**, would not be submitted to the **2d. Principle of thermodynamics**, and be perfectly **reversible** and independent from **time** and, thus, have no **attractor**.

"Their **evolution** does not provoke any contraction of the areas in the **phases space**." (P. BERGÉ et al., 1984, p.43).

L. BRILLOUIN did consider this question in depth, starting from POINCARÉ's ideas, in Chapter VI of his book "Vie, Matière et Observation", under the heading: "POINCARÉ: l'Energétique et le déterminisme" (1959, p.195-217). See also his comments on the related LIQUILLE theorem (Ibid, p.181-191).

3348

SYSTEM (Controlled) ¹⁾

According to B. BANATHY, (rigidly) controlled systems offers the following characteristics: "... they are rather *closed* and have only limited and well guarded **interactions** with their **environments**. These types are *restricted*, have

few **components** and operate usually not more than two **levels** of **decision making**. They are *unitary* in **purpose** with clearly defined **goals** and behave *mechanistically*" (1988, p.29).

"... **Operational objectives** and ways and means of **operation** are clearly prescribed; there is little or no room for self-direction at the **operating levels**.

"... Rigid **structure** and well defined **stable relationships** are established among the various system **components**, with little **systems dynamics** and only minor **changes** over **time**...

"Methods that might be appropriate include: **deterministic** methods that rely on quantification and mathematical **representations** and **simulations**, problem focused **operational research** methods, certain **systems engineering** methods, **linear systems analysis**, etc." (Ibid).

BANATHY gives as examples: "**man-machine systems**, assembly line work groups, primitive socio-economic systems" (Ibid). These latter are generally strongly ritualized and thus offer a very restricted **frame** for **activity**.

3349

SYSTEM (Cybernetic) ²⁾

No system can persist if not "cybernetic", i.e. containing **feedbacks**, **regulations** and **controls** (N. WIENER), being endowed with **variety** (W.R. ASHBY), being **autopoietic** (H. MATURANA and F. VARELA), and in **autonomous relations** with its **environment** or **suprasystem** (P. VENDRYES, J.van GIGCH).

R. VALLÉE describes cybernetic systems as follows: "They are **dynamical systems** that possess **input**, **state** and **output**, and consequently an **evolution** equation. Such a system is cybernetic if it is possible to distinguish an **observational** sequence (of the **inputs**), followed by a **decisional** sequence leading to the **effectors organs** (related to **outputs**), being well understood that the **observational** sequence allows the system to observe its **environment** and *itself*. In this way a basic **feedback loop** is instaurated which calls upon various **communication modes** (**transmission** of **perceptions** and **decisions**) which justifies the cybernetic qualification" (1995, p.26).

It ensues from this **description** that cybernetic systems are **co-evolving** with their **environment** (p.89-90).

VALLÉE uses this **understanding** to construct his "**epistemo-praxeology**".

Another interesting description is E. LASZLO's according to whom the general characteristics that cybernetics systems exhibit are:

"1 - **Goal parameters** set in a **control center**

"2 – Sensing **mechanisms** whereby **information** relevant to the system's **goals** is registered in the system.

"3 - **Effector mechanisms** whereby the system acts on its **environment**

"4 - **Transformation rules** or procedures whereby **information** received from the **sensors** is compared with **information** about the **goal-states** and an **error-correcting signal** is produced to modify the **behavior** of the **effectors**".

LASZLO adds: "The **function** of correcting for **deviation** from the **paths** of **goal-attainment** is that of the central **regulator**. It must contain a long term **memory** which stores the system's **norms**, i.e. the **goal-conditions**, which the system pursues by means of its **deviation-reducing behavior**" (1974, p.186).

LASZLO understands that these characteristics are proper to living **organisms** and socio-political systems as well as artificial **control** systems. They are probably inherent to *anything* that could be somehow described as a system: the sun, our planet, an **ecosystem**.

3350

SYSTEM (Decomposable) ²⁾

"A system for which there exists a means of decomposing it into **parts** or **subsystems**" (P.H. ROOSEN – RUNGE, 1966, p.13).

ROOSEN – RUNGE adds: "Only decomposable systems can have a **structure**" (Ibid).

While this is evident, it may to present the concept is ambiguous: A non-decomposable system is no system at all, but only an **element**... if there exists somewhere a non-decomposable **element**! H. SIMON's view of near-decomposability is more precise.

He considers **interactions** between **elements** at different **levels**, which implies that decomposable systems must, in principle, be **hierarchical**. Furthermore, at each **level** he observes the **interactions** between **elements**, that can be strong, moderate or weak (or very active, frequent, or rare). He does this by using **matrixes**.

He also links the evolutive capacity of systems to the frequency of the existence of **stable combinations** between **elements** in defined **neighborhoods**. (This is quite similar to KAUFFMAN's "**frozen cores**"). For him the necessary **time** for a great system to spontaneously **self-organize** from its elementary **components** grows geometrically in relation to the number of the **components**. This is why **evolution** is a **phenomenon** hierarchized in **time**. (see "**Hora and Tempus**" parable).

A curious consequence, also stated by SIMON, is that, if a **hierarchy** of **subsets** exists, in a more or less constant quantity, then the **time** necessary to constitute a system of **n elements** will grow only in relation to **log_n**.

Thus, **hierarchy** provides systems with an evolutive advantage.

SIMON also observes that, when climbing from lower to higher **hierarchic levels**, the **interactions** between **elements** become ever weaker. He gives as an example that, while the **energies** of typical covalent atomic links are in the bracket of 80 to 100 K. calories per mole, the hydrogen energetic links in organic molecules are only about 10 K. calories per mole, and so on. According to SIMON this weaker linking **energies** at higher **hierarchic levels** allows for **transformations** at the higher **level** without **disturbances** at the **level** of the lesser **subsystems**, i.e. guarantees global **stability** (SIMON, 1977 – 1990).

3351

SYSTEM (Description)²⁾

G. KLIR proposes the following conditions as needed for a satisfactory description (in his word "definition") of any system:

"1. It should be based on characteristics traits which we assume to be completely known.

"2. It should be based only on constant traits, since we do not want to consider a **change** of temporary traits as a **change** of the system.

"3. It should be based only on those traits by means of which it is possible to determine all the other (secondary) constant traits; i.e., the definition must neither be overdetermined, nor underdetermined" (1965, p.32).

These conditions are important for KLIR's **re-constructability analysis**.

3352

SYSTEM (Deterministic)²⁾

A system for which "a given **time-invariant** relation among sampling **variables** can be expressed in terms of a **behavior function**" (G. KLIR, 1991, p.58).

In a less abstract and rigorous way, B. BANATHY thus characterizes deterministic systems:

"Systems of this type are more **open** (note: than rigidly **controlled systems**) to their **environment**, but are still closely guarding their **boundaries**. They have more **variables** and the relational arrangement of their **components** is more complex than that of the rigidly controlled type. They still operate in a **mechanistic** mode with clearly defined **purpose** and unity of **goals**

"... **Goals** are clearly set, and **operational objectives** are prescribed. Ways and means of operating are self-selected. This type has some limited self-direction.

"... **Structure** is more complex than that of the rigidly **controlled systems**, and **relationships** among the **components** are also increased. Some minor relational and **structural changes** can be expected to happen through **time**. This type of system is still a **steady-state system**...

"Methods that may be applicable include: **Operations research** and **systems analysis** methods, **living systems process analysis**, **information theory** based on engineering, **negative feedback** based cybernetic methods of systems **control** and **adjustment**, **management by objectives**, etc." (1988, p. 29).

BANATHY gives as examples "traditional bureaucracies, centralized (national) educational systems, small business and industry".

Deterministic systems are ill prepared to cope with turbulent **environments** and are frequently destroyed when confronted to these.

3353

SYSTEM (Dissipative)²⁾

Any system that dissipates **energy**, be it or not able to compensate its losses.

The **structuring** dissipation concept was introduced as early as 1908 by the French physicist H. BÉNARD, but was retrieved from oblivion by I. PRIGOGINE, in relation to his study of **thermodynamics** of systems **far-from-equilibrium**. (starting 1947).

In opposition to **conservative systems**, the dissipative one is dependent on **time** and thus **irreversible** and submitted to an **attractor**, as it dissipates **energy**.

P. BERGE, Y. POMEAU and Ch. VIDAL write: "In some cases... there exists a **function** of the dynamical **variables**, the **Lyapunov function**, which is positive and decreasing in a monotonic way with **time** (*which is a proof of irreversibility*)". However the **Lyapunov function** does not always exist. "A dissipative system may have a **evolution regime** quite more complicated than a simple decrease, when the **dynamics** include at the same time the effects of the **dampening** and a **mechanism** of maintenance of movement which fights this **dampening**" (1984, p.23).

In such cases, the **attractor** may become **fractal**.

3354

SYSTEM (Dynamic)^{1) – 2)}

A system "to which **events** occur, whose **state** changes over **time**" (R.L. ACKOFF, 1972).

ACKOFF also calls it "multi-state".

It is difficult to conceive a system that would not be dynamic. Even very **stable systems**, like fossils, are merely the **present**, and of course not eternal result of a long physico-chemical **transformation**. The expression is thus somewhat tautological!

E. OTT and M. SPANO, who investigate the possibilities of controlling **chaos**, give a more elaborated definition of what they call a dynamical system: "One whose **evolution** is **deterministic** in the sense that its future is determined by its current **state** and past **history**" (1995, p.34).

This definition implicitly contains the possibility of **chaotic behavior**, because of the possible "exponential sensitivity" to **initial conditions**.

3355

SYSTEM (Equifinal)²⁾

"A system that has the property of reaching the same final **state** almost regardless of the **initial state** and **input sequence**" (G. WEINBERG, 1975, p.209).

There is a hidden paradox in this concept. Each system has only one way to go to its final **state**: the experience cannot be repeated. Various systems may of course be compared. But no two systems are identical, so this too is un-conclusive.

The only absolute equifinal property has been deftly described by St. BEER: "Death is equifinal". This reflects basic **thermodynamics**.

3356

SYSTEM (Ergodic)²⁾

A system which will pass through every possible dynamical **state** compatible with its **energy**.

P. COVENEY explains: "...we can use **phases portraits**" to show how an ergodic system behaves. But in this case, we portray the initial **state** of the system as a bundle of points in **phase space**, rather than a single point... In a non-ergodic system, the bundle retains its shape and moves in a periodic fashion over a limited portion of the **space**... In an ergodic system, the bundle maintains its shape but now roves around all parts of the **space**" (1990, p.52).

In a **chaotic system**, "...the bundle, whose volume must remain constant, spreads out into ever finer fibers, like a drop of ink spreading in water; eventually it invades every part of the **space**. This is a consequence of what is called LIOUVILLE's theorem... The total probability must be conserved (and add up to 1): the bundle behaves like an incompressible fluid drop. This is an example of a "mixing ergodic flow" and manifests an approach to **thermodynamic equilibrium** when the **time evolution** ceases" (Ibid.).

An ergodic system is thus the one for which the global **set** of **trajectories** if well defined, while individual ones remain probabilistic.

About **ergodicity** of **Markovian systems**, G. PASK writes: "... the **state** (Note: i.e. the **global state**) of the **Markovian system** is invariant and it can be shown that the values in the **distribution p^*** are independent of the initial **state i** . But any **representative system** can move away from any **state** to any other **state**. In the **phase space** the **state** points of the ensemble are in continual motion, because a **representative system** can always reach any of the **states** (none of the **transitions** are impossible), the

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

average **population**, at any instant, being determined by p^* . The **equilibrium** is called ergodic and the set of **states** which can be visited (in this case all the **states**) is called an **ergodic set**" (PASK, 1961a p.122-3).

PASK shows furthermore that a system can be at the same time ergodic and **cyclic**.

As proved by KOLMOGOROV, a basically non-ergodic system may however contain ergodic bundles or regions (S. DINER, 1992, p.355).

3357

SYSTEM (Exosomatic) ⁴⁾

The global **human system** which is based on, but enfolds, the genetic and the cultural system.

S. GOONATILAKE, who introduces this concept, understands that the accelerating **growth** of global **information** systems is leading to a kind of meta-control over the biological and social **strata** of **human systems**, through integrating **flow lines** of **information**, which enhance cohesiveness by **symbols** transmission (1991, p.83-85).

3358

SYSTEM (Far-from-equilibrium) ²⁾

A system far-from-equilibrium undergoes wide **fluctuations** and may come very close to a **threshold of instability**. A still wider **fluctuation** may cause it to cross such a **threshold**, which becomes a **bifurcation** point where the system may jump to another **steady state**. In **chaotic systems**, such **bifurcations** may become quite frequent, creating a multiplicity of possible **fractal stability basins**. Sometimes, beyond such a crisis point a higher organized **state** may emerge, associated with a higher **level** of **entropy** production (I. PRIGOGINE).

3359

SYSTEM (Formal) ²⁾

"A collection of abstract **symbols**, together with a **set** of **rules** for assembling the **symbols** into strings" (J. CASTI, 1994, p.121).

CASTI adds to this definition: "Such a system has four **components**:

"**Alphabet**: This is simply the **set** of abstract **symbols** themselves. These may be as primitive as the **symbols** + and -. But they could also be much more concrete, such as the characters of the latin **alphabet**, along with the **symbols** for punctuation, logical **combination** and the like

"**Grammar**: The grammatical **rules** of the system specify the valid ways in which we can combine the **symbols** of the **alphabet** to form finite strings (words), as well as how such strings may be combined into large statements. Statements of this type are termed *well-formed*.

"**Axioms**: A set of well-formed statements that are taken as given strings of the system are called axioms... Thus, an axiom is a string of **symbols** that we accept as a valid statement *without its having to be proved* (italics ours).

"**Rules of inference**: These are the procedures by which we combine and change axioms and other well-formed statements into new well-formed strings" (1994, p.121).

CASTI adds an important caveat: "... it is evident that in a very definite sense the theorems of a formal system are already present in the axioms and **rules of inference**. All a proof sequence does it to make explicit that which is already implicit" (p.123).

Thus formal systems are *closed* and, for this reason, submitted to the limits of **GÖDEL's incompleteness theorem**.

3360

SYSTEM (Generative) ²⁾

Any systemic **model** sufficiently general to be used to represent the **set** of possible **transformations** for a **category** of systems.

G. KLIR states: "Since the overall relations among basic **variables** and those derived from them by various **translation rules** (e.g. **lagged variables**) can be utilized for describing a **process** by which **states** of the basic **variables** are generated within the delimited **support set**, systems on this **level** are called generative systems".

KLIR gives as examples: "Finite-state **machines** (deterministic or probabilistic), **Markov chains**, and differential equations with constant coefficients", and adds: "Each of them characterizes a relation among the **variables** involved, which does not change with the relevant **support set** (**time** or **space set**). This relation makes it possible to generate specific **data sets**, one for each initial or **boundary condition** and for a given **support set**" (1991, p.53).

3361

SYSTEM (Goal directed) ^{1) - 3)}

Any well integrated system may be considered as a goal-directed, i.e., tending or trying to reach some precise and (more or less) permanent goal.

However, this concept is a difficult one.

A **composite system**, endowed with a very low degree of **integration**, tends to go back to its characteristic **critical states**. However this has obviously no volitive undertones: it is just what a loose, but not totally unrelated variable mass of **elements** *does*, due to mere physical **random interactions**. This could be qualified either as **dynamical stability** or instability!

A more integrated system acquires **organizational closure** and **autopoiesis** (i.e. **self-reproduction** capacity) and its global goal is thus inscribed into its internal logic, i.e. to maintain itself in existence.

By stages, from simple **living systems** to the highest and most complex and integrated ones, a growing measure of **self-regulating** capacity leads to the voluntary manipulation of inside and outside **regulations**, which become "**control for**", through manipulation of the **environment** and **anticipatory adaptation** through **feedforward**. Thus, "goal directed" evolves into "goal seeking" in a conscious sense.

Besides, in **complex systems**, the global **survival goal** may become subdivided into a great number of auxiliary **goals**, sometimes **hierarchized**, and whose harmonization may become a very difficult problem.

G. KLIR discussed "goal-oriented systems" and multigoal-oriented systems" in a very close **meaning** and proposed interesting ways to modelize them (1991, p.143-161).

It is also somewhat difficult to draw a precise separation line between "goal-oriented" and "**goal-seeking**" systems (see hereafter).

3362

SYSTEM (Goal-seeking) ^{1) - 3)}

"(A system) that can respond differently to one or more different external or internal **events** in one or more different external or internal **states** and that can respond differently to a particular **event** in an unchanging **environment** until it produces a particular **state** (outcome)" (R.L. ACKOFF, 1972).

R.L. ACKOFF explains: "Production of this **state** is its **goal**. Thus such a system has a *choice of behavior*. A goal-seeking system is **responsive**, but not **reactive**. A **state** which is sufficient and thus deterministically causes a **reaction** cannot cause different **reactions** in the same **environment**" (Ibid).

Thus, a goal-seeking system is endowed with some measure of **autonomy**.

→ "**Goal-seeking system**".

3363

SYSTEM (Heterogeneous) ^{1) - 2)}

A system made of different classes of complementary **components** and **subsystems**.

Any system is heterogeneous, but it is a matter of degree. Heterogeneity is a necessity, in accordance to the **law of requisite variety**, for good **adaptiveness**. Heterogeneity does not however precludes **organization**, which is needed for **coherence**.

The most **complex systems** are also the most heterogeneous ones.

3364

SYSTEM (Heuristic) ^{1) - 2) - 4)}

A system that can formulate its own **goals** and **objectives** (Adapted from B. BANATHY, 1988, p.29).

Only human systems are heuristic.

BANATHY describes them as "... *complex* and *systemic* in their **functional** and **structural** arrangements and... *open* to, and *coevolving* with their **environments**.

"Overall **policy** is set for heuristic systems; and within their **policy framework goals, objectives**, ways and **means**, and **methods of operation** are self-selected.

"Significant relational **changes** and some **structural changes** may occur through **time**. **State changes** are evolutionary and are directed by **design**. **Emergence**, **ambiguity** and **uncertainty** surround **state changes**.

"**Methods** in general are built upon **cybernetics** and **general systems theory**, and systems based organizational theories. Applicable **methods** include **living systems process analysis**, **systems design**, **soft-systems methods of analysis and management**, **double-loop organizational learning** and **consensus building**" (Ibid).

Furthermore, heuristic systems "... have to learn to cope with the explosive increase of relevant **knowledge**, **environmental complexity** and **turbulence**. Furthermore, the **changes** faced... increase as to their intensity, **variety** and dimensionality" (Ibid, p.31).

3365

SYSTEM (Hierarchic) ^{1) - 2)}

"A system that is composed of **interrelated subsystems**, each of the latter being, in turn, hierarchic in **structure** until we reach some lowest **level of elementary subsystem**" (H. SIMON, 1965, p.64).

The **concept** has been put to good use by SIMON in his parable about the two rival watchmakers "**Hora and Tempus**", which shows how to use the **recursive** character of hierarchy for the practical study (and guidance!) of hierarchic systems.

The definition of the "lowest elementary **subsystem**" (or **module**) is however a **modeling decision** to be taken.

Altogether, not all systems are hierarchic, at least in their formation **period**. **Networks** seem to be self-constructing their **organization**, which does not seem to be necessarily hierarchic.

In any case, SIMON's concept and **model** are very useful to clear the hierarchy concept of its authoritarian overtones, giving it a purely **organizational meaning**.

Transversal and bi- or multi-lateral **interrelations** among and between **subsystems** are not, and should not be, excluded under the hierarchical **order** concept. (see "**Heterarchy**")

→ "**System (nearly decomposable)**"

3366

SYSTEM (Homeostatic) ^{1) - 2)}

A system that remains static while its **elements** and **environment** are dynamic.

This definition is adapted from R.L. ACKOFF, who explains: "Thus a homeostatic system is one that retains its **state** in a changing **environment** by internal **adjustments**. A house that maintains a constant temperature during changing external temperatures is homeostatic. The **behavior** of its heating **subsystem** makes this possible" (1972, p.85).

Comparing this concept with W. CANNON's one, it would seem somewhat too narrow.

It could be argued that the homeostatic system is static only "by and large", and this, furthermore in two different senses. First, such a system really oscillates within a more or less narrow band of possible **states** determined by the unavoidable **feedback delays** of its **controls**.

Secondly, **concrete systems** incur in an **ageing process** which slowly modifies their general **state** in an **irreversible** way.

3367

SYSTEM (How to define the meaning of a) ^{1) - 4)}

C. WEST CHURCHMAN writes (1991, p 29-30): "... we can outline five basic considerations that the scientist believes must be kept in mind when thinking about the meaning of a system:

1. The total system **objectives** and, more specifically, the performance measures of the whole system.
2. The system's **environment** (the fixed **constraints**).
3. The **resources** of the system.
4. The **components** of the system, their **activities**, **goals**, and measures of performance.
5. The **management** of the system."

Obviously, this listing refers to human organizational systems and should be adapted for different classes of systems like physical, biological, mechanical ones, for example.

3368

SYSTEM (Hypothesis of the lone) ³⁾

R. VALLÉE proposes the hypothesis of the "lone system", being an observing system unique in a given **environment** and emphasizes the difference in its quality of **knowledge** "as compared with the case of a collectivity of such systems" (1991a, p.143).

A lone system exists within a **universe** that it is able to know only within the limitations of its own perceptive and interpretative capacity. It can be said that it remains secluded within its own epistemological ability (VALLÉE's "**epistemological subjectivity**").

Its relation with its **universe** depends on its own characteristics as an **observation operator** and on its aptness as a **decision operator**. VALLÉE makes clear that "We suppose furthermore that the system is what we call a *cybernetic system*, i.e. a system able to observe its **environment** and itself" (Ibid).

On such a base the system can observe, decide and act, modifying its **environment** and itself, but strictly within the limits of its so-called **epistemological subjectivity**. This situation is unavoidable and could be improved only to a point by **conversation** and **consensus** among various systems within a common **environment**.

3369

SYSTEM (Ideal-seeking) ⁴⁾

"... a **purposeful system** which, on attainment of any of its **goals** or **objectives**, then seeks another **goal** and **objective**, which more closely approximates its ideal" (R.L. ACKOFF, 1972).

According to ACKOFF: "An ideal-seeking system is thus one which has a concept of 'perfection' or the 'ultimate desirable' and pursues it systematically; that is in interrelated steps" (Ibid).

Some question marks remain:

1. what is "perfection" or the "ultimate desirable"?
2. and, if it can be defined, in which way can the system construct it?

3370

SYSTEM (Input-output)

→ **Input-output matrixes**

3371

SYSTEM (Integrated) ^{2) - 4)}

A system whose **components**, **parts** or **subsystems** are strongly interconnected and interacting.

Strictly speaking, a system that would not be at least minimally integrated would not be a system at all. However, a vegetal, animal or human **colonial system**, for instance, is looser than a biological one.

In an integrated system, **processes** and **functions** are permanently and closely interdependent. Their **relations** are **regulated** by a **hierarchy of controls**. The system cannot survive the complete destruction or impairment of any of its **critical subsystems**, nor the severance of their **interactions**. None of the **subsystems** can normally survive outside of the system.

Integrated systems are also characterized by the existence of an internal **environment (in-vi-ron-ment)**, of which the **subsystems** depend for their **survival** and which they collectively maintain. The most integrated the system, the lesser the number of its **elements** that interact directly with the **environment**.

Biological systems are more integrated than **ecosystems** and these, in turn, more so than **composite systems**. Man seems to be the most complex integrated **living system**, due mainly to the capacity to pick up and **process information**.

Systems that become too strongly integrated run the risk to become rigid and blocked, thus loosing **adaptive** capacity, and risking destruction. The demise of U.R.S.S. was a good example.

3372

SYSTEM (Irreversible)¹⁾

Any **concrete system**, as a necessary user of **energy**, is unavoidably **irreversible**, as a consequence of the **2nd law of thermodynamics**. It may however be **dynamically stable** (PRIGOGINE's Principle of **minimum entropy production**) or be **far-from-equilibrium** and **dissipative**.

Only **models of hamiltonian** systems are in principle reversible. But this is possible only in theory or at most for the **modelization** of relatively simple and strictly **deterministic relations**.

3373

SYSTEM (Isolated)²⁾

A system that makes no exchange of any kind with any **environment**.

As stated by I. PRIGOGINE and P.M. ALLEN such a system: "... whatever its nature, will approach **thermodynamic equilibrium**, a **state** characterized by the maximum value of **entropy**, that is of "**disorder**" (1982, p.5).

This is a largely abstract concept. Indeed it is the **model** of a system rigorously submitted to the **2d law of thermodynamics**.

By definition the isolated system does not absorb nor emit any **energy, matter** or **information** and could thus not even be observed. While useful in classical physics and chemistry, it can not be used in biology nor social sciences (nor even, in some cases in physical sciences). This explains why classical **thermodynamics** had to be extended during this century to **open and irreversible systems**.

According to G. SOMMERHOFF: "An isolated physical system in the classical sense is determined by the **initial state**". This means "that the current **state** of the system can be expressed in terms of single-valued **functions** of the **initial state** and the **time**". SOMMERHOFF gives the example of the pendulum, for which

the isolated system **model** does not take in account any friction or **disturbance**, which, of course, are always acting on **concrete systems**.

The isolated system, furthermore is practically always **linear** and generally **deterministic**. G. SOMMERHOFF writes about this point: "In a **state-determined system** every possible initial **state** determines a single line of **behavior** only. And although different lines of **behavior** may at one point or another fuse, *they can never bifurcate*" (1969, p.158).

The concept of isolated system is particularly confusing in the case of **living and social systems**. As stated by A. RAPOPORT: "an isolated system cannot be a **living system** (at least not for long)" (1966, p.6).

The misunderstanding of this aspect, very common since DRIESCH vitalism until the 1930es, blocked partly the development of biology during half a century, with among exceptions, WOODGER and von BERTALANFFY's work.

3374

SYSTEM (Isomorphic)

A system whose all characteristics would be in a one-to-one correspondance with all those of another system.

This is clearly another semantic inconvenience: No two systems are ever identical.

It would merely be conceivable that the *models* with selected characteristics taken out of two *similar* systems, could be isomorphic.

But we may be satisfied with partial isomorphies, that can be very useful to create generalizing **models**.

→ **SYSTEMS (Isomorphic)**

3375

SYSTEM (Life cycle of a)¹⁾

All systems – except possibly the most elemental particles described or postulated by micro-physics – go through a **life cycle**, that can be described chronologically as follows:

- **autogenesis**: shaping of the entity (**entitation**) by **association** of formerly independent **elements** (V. CSANYI);
- **morphogenesis**: structural and functional **development** of the system by internal **differentiation** or/and absorption and **assimilation** of external **elements**;
- **homeostasis**: structural and functional **stabilization** of the system, with **fluctuations** within **limits**;
- **sclerosis**: by progressive reduction of the **fluctuation** and **regulation** capacity;
- **dissolution**: terminal loss of **coherence, heterogeneity** and **identity** and dispersal of the constitutive **elements**.

This is even true for very stable atoms caught in some cosmic cataclysm.

However, in some cases, a system may leave some trace (as for example petrified "wood", which is in fact stone).

H. PRAT called these traces "**aura**".

3376

SYSTEM (Linear)²⁾

A system which responds to an increase or decrease of some **input** by a **change** of the same amount in its corresponding **variable**.

Only very simple systems, in fact simple **functions**, if they may be called systems, can be linear. The real condition of **linearity** is that the system be very poorly **joined** in ASHBY's sense, i.e. devoid of significant internal **interactions, constraints** and **feedbacks**. No **complex system** can be linear more than in a very limited, local and provisional sense.

R. VALLÉE provides a good global overview of dynamic linear systems of differential nature (**continuous**) or recurrent (**discrete time**) (1992, p.114-26).

3377

SYSTEM (Man-machine)^{1) - 2)}

A system composed of a **subsystem** of inter-connected functional **artefacts** (the "machine") and a human individual or groupal **subsystem** which steers or **control** it.

In our technological civilization, there are countless man-machine systems, which are evolving toward an ever-increasing **complexity**, generally characterized by a growing **automation**, and **autonomy**, of the machine **subsystem**.

Man-machine systems are the specific field of study of **systems engineering**.

3378

SYSTEM (META-) TRANSITION²⁾

Transition toward a higher **level of control** in a system.

Such a **process** may take place when the existing cognitive **subsystem** is no longer able to cope with a growing **complexity**, which happens "...if the **variety** of possible actions is larger than (its) capacity for **control**." (F. HEYLIGHEN, 1991).

Through this kind of **complexity emergence** "... a number of **control** systems are integrated into a single **whole** with the formation of a global **control system**" (Ibid).

HEYLIGHEN adds: "...the **emergence of control** leads to an increase of **variety**, whereas the increase of **variety**, if it is large enough, stimulates the **emergence** of a new **control** in a **positive feedback cycle**" (Ibid).

In this way a **hierarchy of controls** builds progressively up. Furthermore: "... once the **control** at the higher or meta-level has emerged, the number of **subsystems** it controls will in general increase. V. TURCHIN calls this **phenomenon the branching growth of the penultimate level**" (Ibid).

→ **Meta System Transition**

3379

SYSTEM (Multi-Agent)

→ **Multi-Agent System**

3380

SYSTEM (Multi-level)²⁾

A multi-level system is not necessarily rigidly **hierarchical** in a unique vertical line of command.

There may exist **communication** lines within the same level between different **subsystems**, and possibly some local **hierarchies** at intermediate levels. Various partial or local **hierarchies** may become unified only at the uppermost level.

Abilities and **regulations** may even be more or less diffuse under the form of local but interconnected **networks**, allowing for a **heterarchical** and **holographic organization**.

3381

SYSTEM (Multistable)²⁾

A system "which consists of many **ultrastable systems**, joined main **variable** to main **variable**, all the main **variables** being part **functions**" (W.R. ASHBY, 1960, p.171).

3382

SYSTEM (Near Equilibrium)²⁾

"Any system characterized by an irreversible **evolution** towards a fixed stationary **state**, called **attractor**" (S.H. STROGATZ & I. STEWART, 1990, p.100-1).

"This type of systems may be described by a quite precise equation, which permits to compute the **stationary state** towards which they tend. Examples of open **dissipative systems near equilibrium** (i.e., which have a **linear** movement equation) are numerous: slow flowing rivers, heat **flow** through a partition, common chemical reactions, motors, etc..." (Ibid).

They are characterized by an "**evolution of entropic type**" "**attracted**" by the most probable **state**, the one of maximum **disorder** (or the one of **stationary state** of the same type...)" (Ibid).

This type of system can however maintain itself in a regime of **dynamic stability** during a more or less protracted **period**, while stabilizing its **entropy** production to the lowest **level** compatible with its characteristics.

When the system finally reaches its **attractor**, it destroys itself as a system and its **elements** recover their **independence**.

3383

SYSTEM (Nearly decomposable)^{1) - 2)}

A system "in which the **interactions** among the **subsystems** are weak, but not negligible" (H. SIMON, 1965, p.69).

The subsystems and their **interactions** can generally be represented in a **matrix** divided into submatrixes, wherein most intersections between columns and lines are void.

SIMON enounces the following propositions relative to these systems:

"a) ... the short run **behavior** of each of the **component subsystems** is approximately **independent** of the short-run **behavior** of the other **components**;

"b) in the long run, the **behavior** of any one of the **components** depends in only an aggregate way on the **behavior** of the other **components**" (Ibid).

SIMON adds: "intra-component **linkages** are generally stronger than intercomponent **linkages**. This fact has the effect of separating the high-frequency **dynamics** of a **hierarchy** - involving the internal **structure** of the **components** - from the low-frequency **dynamics** - involving **interaction** among **components**" (p.72).

According to SIMON, the nearly decomposable system **model** can be widely used, for **social** and **economic systems**, as well as for many physico-chemical systems, whose **parts** are very imperfectly connected.

3384

SYSTEM (Nondeterministic)²⁾

A system in which "the **states** of the generated **variables**... are not determined uniquely by the **states** of the generating **variables**" (G. KLIR, 1991, p.56).

KLIR adds: "Instead, they are generated with some uncertainty, which may, for example, be expressed in terms of conditional **probabilities**... called **behavioral probabilities**" (Ibid).

This is the case for **ergodic systems** and, possibly for **chaotic** ones.

3385

SYSTEM (Nonequilibrium)²⁾

Any system that "... through internal **amplification** or **fluctuations**, may cross **instability thresholds** and form... **dissipative structures**" (E. JANTSCH & C. WADDINGTON, 1976, p.71).

The theory of nonequilibrium systems has been firmly established by I. PRIGOGINE.

The appearance of **dissipative structures** corresponds to the **emergence** of "... new **dynamic regimes** which represent a new ordering principle beyond the thermodynamic branch

(which describes **order** near **equilibrium**). Such **dissipative structures** can be maintained only through **energy** exchange with the **environment**" (Ibid., p.72).

When the new **dissipative structures** become stabilized, the emerged system may settle down at a higher **level** of **entropy** production and thus reach a new **equilibrium** at this corresponding higher **level** of **complexity**.

3386

SYSTEM (Nonlinear)²⁾

Any system with various simultaneously **interacting** causal lines that impede rigorous globally **deterministic behavior**.

L. DOUGLAS KIEL writes: "Linear systems respond to minimal **changes** in their **parameters**, or to external shocks, in a smooth and proportionate manner" (1992, p.30).

It is really very difficult to conceive a system which would be truly **linear**. **Models** of systems are frequently **linear**, indeed. But their **reliability** is generally limited to a small and **short term range** of the system's **behavior**.

DOUGLAS KIEL writes: "A small **change** in a nonlinear system can, however, produce an enormous difference in the **structure** and **behavior** of the system" (Ibid).

However, many small **changes** have no such effects, with the result that we may well believe in a non-existent **long term dynamic** (or even static !) **stability**.

"... external **disturbances** may amplify nonlinear **interactions**, generating **instabilities**, that may initiate a break with the pre-existing **behavioral** and **structural regimes**" (Ibid).

"Nonlinear systems may also reveal a "sensitive dependence on **initial conditions**" (J. GLEICK, 1987).

"A small difference in the **initial conditions** of seemingly similar nonlinear systems can lead to dramatically different evolutionary **paths** and outcomes. ...Any effort at **forecasting** the **behavior** of a nonlinear system is, thus a highly suspect activity" (Ibid).

This is possibly somewhat over-pessimistic: With good **monitoring**, a sufficient grasp of **chaos theory**, and as much as possible consolidated **knowledge** of the various **levels** of **cyclical activity** of the system, some **forecasting** is feasible... but the results should always be taken with caution.

According to DOUGLAS KIEL: "Nonlinear systems exhibit four distinct types of temporal **behavior**...

1) **convergence** to a **stability** or **equilibrium**

2) stable **oscillation**

3) unstable and explosive

4) **chaotic**.

Each regime can appear within the **long term behavior** of a nonlinear system" (Ibid).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Another important aspect is, in P.M. ALLEN et al. words: "... nonlinear systems, operating far from thermodynamic equilibrium, can undergo successive structural instabilities leading to a progressive complexification of their organization and functioning. Such phenomena involve a dialogue between stochastic and deterministic aspects of the system, as the interaction tend to a "self-organization" process of successive periods of stability and instability, where new qualities, traits and characteristic emerge over time" (1984, p.150).

Evolution seems thus to offer a "punctuated" character, as claimed in living systems by GOULD and ELDREDGE.

3387

SYSTEM (Open) ²⁾

A system able to selectively exchange matter, energy and/or information with its environment.

The selectivity is the key aspect, in space as well as in time. The system can be alternatively open or closed to some inputs or outputs. This means that the system has a more or less extensive capability to control its inputs and outputs in relation to its needs. This secures the individuality of the system and connects the open system concept with the autopoiesis and organizational closure ones.

R. ROSEN expresses the consequences as follows: "von BERTALANFFY explicitly showed that a basic characteristic of biological systems could be approached entirely through a functional or relational criterion (i.e. that the system be open) rather than through reductionist analysis of the specific particles of which any particular system happens to be composed".

"(He also stressed) the relation between regulatory phenomena in biology, particularly those which appear to involve purposiveness, and the formal concept of stability" (1973, p.176).

Furthermore, ROSEN adds that von BERTALANFFY had an implicit intuition that the classical thermodynamics was at a loss to explain living systems, a fact that was later explained by I. PRIGOGINE, who introduced the needed amendments. And finally, von BERTALANFFY recognized that an open system could reach the same final state, using different lines of behavior (equifinality).

D. KATZ and R.L. KAHN describe as follows the main characteristics of open systems:

"- They undergo "repeated cycles of input, transformation, output, and renewed input
"- The law of negative entropy (?) states that systems survive and maintain their characteristic internal order only so long as they import from the environment more energy than they expend in the process of transformation and exportation" (1969,p.103). (The excess is used to maintain internal order ... through the pro-

duction of new elements characteristic of the system and used to replace elements of the same type).

"- They possess feedback devices that KATZ and KAHN interpret as follows: "The feedback principle has to do with information output, which is a special kind of energetic importation, a kind of signal to the system about environmental conditions and about the functioning of the system in relation to its environment... The system thus maintains a steady state or homeostasis. This is a dynamic rather than a static balance, however" (Ibid).

"- They tend to differentiation and elaboration, both because of subsystem dynamics and because of the relationship between growth and survival" (Ibid).

"- They are equifinal which means "... that systems can reach the same final state from different initial conditions and by different paths of development" (Ibid).

3388

SYSTEM (Organismic) ^{2) - 5)}

"An open system which either is an organism or can be treated as an organism, where the chief characteristics of an organism are relatively fixed ordering of components, reproduction of the same type or species, and the existence of a life cycle" (O.R. YOUNG, 1964, p.70).

According to YOUNG, the concept, basic in von BERTALANFFY's work, is usable in biology, economics, sociology and political sciences.

Organismic systems are necessarily autopoietic, i.e. endowed with organizational closure.

3389

SYSTEM (Oscillating) ²⁾

A system that fluctuates more or less periodically between defined stability limits.

There is a great variety of oscillations modes, from the perfectly regular to the most complex, and even more or less random as in ergodic systems.

Probably all dynamically stable systems can be considered as oscillators, submitted, in HAKEN's terms, to an order parameter.

However, a system submitted to growing oscillations may run out of control, enter in a far-from-equilibrium situation, reach a bifurcation point and start to produce new dissipative structures. When (and if) it reaches a new minimum entropy producing equilibrium it turns to a new oscillating mode.

→ Oscillators

3390

SYSTEM (Polystable) ^{1) - 2) - 4)}

"Any system whose parts have many equilibria and that has been formed by taking parts at random and joined at random" (W.R. ASHBY 1960, p.173).

What ASHBY has in mind are systems whose parts are "... assured to be state-determined, and thus to have (in themselves) no randomness at all" (Ibid).

Some examples are von FOERSTER's small magnets in his famous "order from noise" experiment, or better still, neurons - natural or artificial.

What ASHBY wants to study is the way such elements, when joined, start to organize themselves spontaneously.

He sums up the result of such a process in the following way: "The polystable system, if composed of parts whose states of equilibrium are distributed independently of the states of their inputs, goes to a final equilibrium in a way that depends much on the amount of functional connection" (p.178).

He adds: "When the connection is rich, the line of behavior tends to be complex and, if n is large, exceedingly long; so the whole tends to take an exceedingly long time to come to equilibrium" (Ibid). As possible examples (admittedly hypothetical) we may consider any complex society, like neurons in the brain or people with diversified roles in a numerous human organization.

ASHBY completes his comment saying: "When the connection is poor (either by few primary joins or by many constancies in the parts), the line of behavior tends to be short, so that the whole arrives at a state of equilibrium soon" (Ibid).

ASHBY's own quite simple homeostat is a good example.

3391

SYSTEM (Primitive)

→ System (Source)

3392

SYSTEM (Probabilistic) ²⁾

A system made from more or less unreliable components.

J.von NEUMANN demonstrated the possibility to construct a globally reliable system from components whose behavior is probabilistic (1956, p.43-98).

This is the case for networks with very numerous components and links among them, probably because a global order appears spontaneously and supersedes local disturbances.

ASHBY's homeostat, as the behavior of its elements becomes ordered as a Markovian process (1958, p.232-4) is also a probabilistic system.

3393

SYSTEM (Purpose seeking) ^{1) - 4)}

B. BANATHY describe this type of systems "... as complex, ideal-seeking systems guided by **images** of the future that they shape themselves". Of course, ideal-seeking systems should not be confused with ideologically constructed ones (but may be sometimes in serious danger to be).

BANATHY states: "They are both *open* and *adaptive* to the **environment** and are shapers of the **environment**. They are *pluralist* and thus able to seek and explore new purposes. They are *systemic* in their arrangements and **behavior**. They exhibit such qualities as **emergence**, self-transcendence, and a tendency for **cooperation** and even **integration** with other systems and reorganization at a higher **level of complexity**" (1988, p.30).

As to their degree of self-direction: "**Policies** are formulated based on **images** of the future that people in the system shape collectively. There is constant search for new purposes; new **niches** in the **environment** that the system can carve out, shape, or incorporate".

As to their **structure/relational state**: "Significant structural **changes** may occur through **time**. **State changes** may be independent of prior **states**. Discontinuity and reorganization at higher **levels of complexity** are expected to happen, directed by purposeful **design**. **Ambiguity** and **uncertainty** are used creatively" (ibid).

Some of the examples given by BANATHY are: "... seeking and designing new institutional roles for the private and public sector; seeking society renewal through the **design** of integrative **community** systems, the **design** of alternative educational systems,... peace development and alternative security systems" (ibid).

This type of systems closely corresponds to JANTSCH's "**purposeful systems**" (1975).

3394

SYSTEM (Purposeful) ^{1) - 4)}

"(A system) which can produce the same outcome in different ways in the same - internal or external - **state** and can produce different outcomes in the same and different **states**" (R.L. ACKOFF, 1972).

Such systems may be **equifinal**.

R.L. ACKOFF explains: "Thus a purposeful system is one which can change its **goals** under constant conditions; it selects ends as well as means and thus displays *will*. Human beings are the most familiar examples of such systems".

He adds: "A system which can choose between different outcomes can place different **values** on different outcomes" (1972, p.87).

This leads ACKOFF to the **concept** of **ideal-seeking system**.

Pursuing this line of thought, W. ULRICH advocates for a "purposeful systems **paradigm**". This idea is synthesized by R.L. FLOOD and M.C. JACKSON: "... in a purposeful system, the ability to determine the purpose must be spread throughout the system; the system should produce **knowledge** relevant to purposes and encourage debate about purposes; and all plans or proposals for **design** should be critically assessed in terms of their normative **content**. **Critical systems heuristics** is about the **design** and assessment of purposeful systems" (1991, p.203).

This trend is now visible in S. BEER's **Viable System Model**; in J. WARFIELD's **Generic Design**; in the FUSCHL type **Conversations**; in J.A. JOHANNESSEN's **Holographic model**; in I.I. MITROFF and H.A. LINSTONE's **Unbounded System Thinking** and in R.L. FLOOD and M.C. JACKSON's **Total Systems Intervention**.

3395

SYSTEM (Purposive) ²⁾

"A **multi-goal-seeking system** the different **goals** of which have a common property" (R.L. ACKOFF, 1972).

ACKOFF explains: "Production of that common property is the system's purpose. These types of system can pursue different **goals** but they do not select the **goal** to be pursued. The **goal** is determined by the initiating **event**. But such a system does choose the means by which to pursue its **goals**" (ibid).

A computer with a **variety of programs** is thus a purposive system (to be distinguished from a **purposeful system** - see above).

B. BANATHY gives the following characteristics of this type of systems:

"Degree of self-direction. Purposes are set for the system, **strategic goals** are prescribed, however operational **objectives**, **methods** and means of **operation** are self-selected.

"(As to the) **structure/relational state**: **State changes** are gradual, influenced primarily by **environmental changes** that indicate the need for **adaptation**. **Structural change** happen slowly over **time** and are coupled with **changes** in systemic **relationships**. Increasing **complexity** in this system type indicates **multi-level hierarchy** and **embeddedness**. Purposive systems may embed **deterministic** and rigidly **controlled** systems.

"**Methods** that are relevant for this type may include those based on cybernetic theory, **systems analysis**, **systems engineering** and **systems design**. **Living systems theory** has special relevance for purposive systems in view of the significance of **information** and **matter** and **energy** processing in these systems. Having freedom for selecting **objectives**, **consensus building methods** also come to play in purposive systems" (1988, p.29).

An interesting comparison can be made with **heuristic systems**.

3396

SYSTEM (Quasi-Periodic) ²⁾

A system submitted to a merely general, but imprecise **determinism** in **time**.

Quasi-periodic systems successive **states**, or **trajectories** are submitted to a **toric attractor**. The **trajectory** does practically never come back exactly to the same point. It remains however within globally stable **limits**.

→ **Quasi-periodic**

3397

SYSTEM (Relevant)

A **human activity system** whose modeling is considered necessary by a manager or an **observer**" (Adapted from R. RODRIGUEZ ULLOA, 1994)

The crux of the issue is in the word "relevant" !

From one side, there may be different views about what are the relevant characteristics of the system. Managers for ex., in many cases consider relevant only those features that are determinant from an economic viewpoint. A union leader or a sociologist may have a different interest.

As to the modelizer, relevance is frequently a matter of selecting **variables** that have a real influence on the system's **behavior** (and at which **time horizon**). His views are not necessarily shared with the "owner(s)" of the problem and it may be difficult to convince them. They may even not be shared among modelizer's themselves!

3398

SYSTEM (Richly or poorly joined) ²⁾

W.R. ASHBY states that a system may have more or less strong or weak internal interactions among its **parts** or **subsystems** (1960, chap.11).

A totally joined system would become at the same time clogged and blocked; if any **element** can communicate freely with any other *at any time* and in any way, no **order** can be defined. Curiously, the result is the same as in a collection of disordered **elements** (the case of the totally entropized **isolated system** - a semantic contradiction, since such a system does not possess anymore any feature).

Thus, a system can be functionally defined only if it is *limitedly* intra-connected, i.e. if its **variety** is limited by **constraints**, i.e., if some **interrelations** are not permitted.

Furthermore there seems to exist an optimum such as the system reaches at one moment the best adapted **level of internal connection** in relation to its functionality, while at the same time, maintaining the best possible **adaptativeness**. Such an optimum must however necessarily be transitional.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

One could also speak of strongly or weakly intraconnected system to make more understandable the somewhat at times esoteric language of ASHBY.

3399

SYSTEM (Second Order)²⁾

"A chain of two storing units (Integrators) with a loopback" (H. ODUM, 1971, p.99).

This is a **systems engineering** concept. It is thus called "... because the differential equation for the whole system has a second derivative. Such systems may oscillate regularly, and when the **input** is variable, undesirably wide **fluctuations** may result. The **oscillator** may get into **phase** with the external **variation** of **input** and go into **resonance** with **variations** and **flows** that are larger than those in the **input**" (Ibid).

3400

SYSTEM (Self-energizing)²⁾

A system which possess sufficient stored **energy** to be able to draw on its **reserves** to react to some external **stimulus**.

G. BATESON gives the following examples: "If I kick a dog, his immediately sequential **behavior** is energized by his **metabolism**, not by my kick. Similarly, when one neuron fires another, or an impulse from a microphone activates a **circuit**, the **sequent event** has its own **energy sources**" (1973, p.379).

However, as stated by BATESON: "Of course, everything that happens is still within the limits defined by the law of **energy** conservation" but "... in general, in the systems with which we deal, the **energy** supplies are large compared with the demands upon them; and, long before the supplies are exhausted, 'economic' limitations are imposed by the finite number of available alternatives... A telephone exchange at a time of emergency may be 'jammed' when a large fraction of its alternative pathways are busy. There is, then, a low probability of any given **message** getting through" (Ibid).

A **complex system** has generally "... the necessary **circuit structure** so that (its) **energy** expenditure can be an inverse **function** of **energy input**" (Ibid., p.457).

Such a system, when its **energy reserves** are lowering, will generally redirect their use to replenish them.

This was the general idea of W. GREY WALTER's electronic tortoises.(1955).

3401

SYSTEM (Self-modifying)^{1) - 2)}

A system able to generate new **interrelations** between its internal **processes**.

According to G. KAMPIS, who introduces this notion, the general conditions of existence of the system are modified by its own **activity**. As a result the system must readapt itself in order

to survive. This entails the shaping of new **interrelations** between **processes** and may lead to a deep **transformation** of the system (1989, p.87-98).

Contemporary complex **human systems** seem to be self-modifying, which may explain that they become ever more difficult to manage.

Self-modification seems to be a later stage of **self-organization**, but its status in relation to **autopoiesis** is not yet quite clear. Self-modification does not seem compatible with M. ELGEN's **hypercycle**, for instance.

3402

SYSTEM (Self-organizing)²⁾

I. A system that construct itself by joining **parts** formerly separated.

This is the transit from no-organization to organization.

This meaning, according to W.R. ASHBY, who proposed it (see 1981, p.58), is "simple and unobjectionable". It possibly looks simple because we see it at work so frequently. However the **initial conditions**, **causes** and ways of the shaping of specific **links** and **interactions** among the newly connecting **elements** in this **autogenesis process** still remain relatively obscure.

Thereafter, still in ASHBY's words the system changes "from a bad organization to a good one". "*Bad*" seems unluckily valorative. In any case, the system must first of all come into existence, a **process** now quite well explained by V. CSANYI's **models** of the **zero system** and its **autogenic precursors** (1989, 1993). It can then change from a simpler to a more **complex** type of **organization**, or from one type to another one, in accordance with varying internal or external conditions. This lead us to the second definition.

2. "A system able, with no explicit outside help, of improving its **performance** while pursuing its **goals**" (Adapted from G. KLIR, 1991, p.156).

This is obtained by modifying (see preceding entry) the organization of the **interactions** between the **elements** of the system.

This kind of **processes** has been investigated by H. HAKEN (**synergetics**) and also through the study of **networks** progressing toward a more ordered organization. Self-organization is also closely related to the **emergence** of **autopoiesis**, because an already existing system is "**organizationally closed**" and thus able to modify its internal **structures** and **processes** only within very narrow **limits**. This is the case for ex., of any **living system**.

Finally, giant **fluctuations in dissipative systems far-from-equilibrium** (I. PRIGOGINE et al.) may be conducive to the **emergence** of a higher **level** of organization, a **process** also possibly more related to **autogenesis** than to self-organization.

3403

SYSTEM (Self-referential)

John MINGERS proposes the following classification of self-referential systems (1999, p. 28)

3404

SYSTEM (Self-referential)²⁾

"A system that changes the **states** of its **components** in a **operationally closed way**" (P.M. HEJL, 1992, p.115).

HEJL states the following consequences:

- Self-maintaining systems are necessarily self-referential;
- However, not all self-referential systems are self-maintaining (Ibid).

HEJL gives as an example of this last case, the **brain**, which could not be self-referential if it was not maintained by the whole biological system.

This neatly shows the difference between **independence** (inexistent), and **autonomy** in **autopoietic systems**.

3405

SYSTEM (Self-reproducing)²⁾

This is now such an ambiguous expression that no reliable definition seems possible. At least five different meanings can be identified. Self-reproduction could be said to occur in:

1. the division of a **cell**, transmitting its genetic material without modification to the resulting new **cells**;
2. the production by cloning of new plants also genetically identical to the original one;
3. the production of new plants only by vegetative propagation, as for example by rhizomes in **colonies** of poplars, or stolons in strawberry plants;

These first three **meanings** are relative to **concrete living systems**.

From an abstract **viewpoint**, we may distinguish:

4. the self-reproductive **automaton**, as for example in some cases in J. CONWAY's **Games of Life**;
5. the **autopoietic** reproduction of a system through which the system more or less continuously reconstructs itself by the **cyclical** or **recursive** reproduction of its **elements** and the characteristic **links** amongst them.

These different **meanings** are obviously related. Remains to be seen if the two last ones can be compatibilized, really becoming general **models** for the former ones, and how.

3406

SYSTEM (Source)^{2) - 3)}

"A **set of variables**... established as a result of our **interaction** with an **object** of interest" (G. KLIR, 1993, p.41).

This definition corresponds to **reconstructability analysis**.

Source systems can be viewed "as sources of empirical **data** regarding specific **attributes** of the investigated **object**" (KLIR, 1991, p.221).

KLIR writes: "The most primitive epistemological **category** consist solely of a *experimental frame*, a **set of variables**, their **state sets** with appropriate **observation channels**, **time** (as a **parameter** within which the **variables** are observed), and an appropriately defined **time set**. The term *source systems* is usually used for systems defined at this **level** to indicate that such systems are, at least potentially, sources of empirical **data**. Systems on different higher **epistemological levels** are distinguished from each other by the **level of knowledge** regarding the **variables** of the associated source system" (1988, p.151).

KLIR makes also an important observation: "Since we deal with systems distinguished on **objects** and not with the **objects** themselves (in their totality), it is not operationally meaningful to view **complexity** as an intrinsic property of **objects**. While complexities of **objects** may exist in the **ontological** sense, they are **epistemologically** and **methodologically** vacuous, in contrast to **complexities** of systems" (1993, p.41).

This reminds us of "the map, which is not the territory".

→ "ontological skepticism".

A zoologist, for instance, would observe different characteristics and **variables** in order to study a variety, a species or a family of animals.

The source system concept seems quite close to J.G. MILLER's "**concrete system**". It surges from something "out there" that we observe in a defined way for some defined **purpose**.

3407

SYSTEM (Stable)^{1) - 2)}

"...(a system that) has the property that if displaced from a state of **equilibrium** and released, the subsequent movement is so matched to the initial displacement that the system is brought back to the **state of equilibrium**" (W.R. ASHBY, 1960, p.54).

Such property could be considered as a generalization of the **Principle of LE CHATELIER**.

ASHBY emits a series of interesting comments related to the properties of the stable system.

He writes: "A **variety of disturbances** will therefore evoke a **variety** of matched reactions"... and "... the **behavior** of a stable system may be described as **goal seeking**" (Ibid).

Furthermore "An important feature of a system's **stability** (or **instability**) is that *it is a property of the whole system and can be assigned to no part of it.*"

Or, in other words: "*The stability belongs only to the combination; it cannot be related to the parts considered separately*" (Ibid, p.56).

This implies that no change can be introduced in some specific **part** of the system without triggering some side effects and, possibly a complete reordering of the **whole** system, or even its destruction.

ASHBY expresses the same idea as follows: "In a stable system the effect of fixing a **variable** may be to render the remainder unstable"... and "... *the presence of stability always implies some coordination of the actions between the parts*".

The stable system, as a **model**, corresponds also to PRIGOGINE's concept of the **thermodynamic system near of its point of equilibrium**, i.e. not submitted to giant **fluctuations** that could transform it radically or destroy it.

Stable systems are also called "**Equilibrium Systems**", in opposition to **critical systems**. P. BAK expresses their **stability** condition as follows: "... under very restrictive conditions, **equilibrium systems** can exhibit **scale-free behavior**" (1996, p.35). This seems to be equivalent to PRIGOGINE's concept stated in his **theorem of minimum entropy production**.

3408

SYSTEM (State-determined)²⁾

A system whose **path** is uniquely determined, regardless of how the system arrived at the given initial **state** (After HALL & FAGEN, 1956, p.25).

W.R. ASHBY thus explains the concept: "The **field** of a state-determined system has a characteristic property: through no point does more than one **line of behavior** run" (1960, p.27).

Or, "A finite **set of variables** for which, at any instant, the **state transition** is completely determined by the present **state**" (Ibid).

In other words, in a state-determined system, there are no **bifurcations** because there does not exist any **indetermination** in any **line of behavior**: the system is wholly **deterministic**.

ASHBY observes that: "Because of its importance, science searches persistently for the state-determined" (Ibid, p.28).

He could have added that contemporary science, after running into many dead ends, is starting in earnest to research non absolutely **deterministic** systems, whether **non-linear**, **far-from-equilibrium**, or **chaotic**. See for example R. ROSEN's paper on "The Physics of **Complexity**" (1991 c, p.493- 500).

3409

SYSTEM (State-maintaining)²⁾

According to R.L. ACKOFF, a system is state-maintaining if:

"1) it can react in only one way to any one external or internal **event** but

"2) it reacts differently to different external or internal **events**, and,

"3) these different reactions produce the same external or internal state" (1972, p.85).

The following comment by this author seems to show that self-maintenance is different from **organizational closure**: "Such a system only reacts to **changes**; it cannot respond because what it does is completely determined by the causing **event**. Nevertheless it can be said to have the *function* of maintaining the state it produces because it can produce this state in different ways under different conditions" (Ibid).

3410

SYSTEM (State-transition)^{2) - 3)}

"A *state-transition system* is defined in terms of a **set** of overall **states** based upon a particular **mask** and a specification of conditions for transitions between these **states**" (G. KLIR, 1988, p.151).

It is thus a collection of **data**, not yet conceptually organized, except as a result of the characteristics of the selected **observation** device, and, obviously, of the **purpose** which oriented this **selection**.

Accordingly, a systemic **model** cannot be constructed without the introduction of some supplementary conjectures about the global signification of the **data**.

3411

SYSTEM (Static)^{2) - 3)}

A system "to which no **events** occur" (R.L. ACKOFF, 1972, p.84).

R.L. ACKOFF gives the example of a table "... a static **concrete system** consisting of four legs, top screws, glue, and so on. Relative to most research purposes it displays no **change** of structural properties, no change of state" (Ibid).

This is of course a situation defined by the **observer's purpose**. There are always **dynamic** aspects in any system, even if, for some reasons, they are not taken in account in some cases.

Obviously, when considered from a static **viewpoint**, a system is not very interesting.

3412

SYSTEM (Stationary)²⁾

"A system which is in dynamic or statistical **equilibrium**" (G. PASK, 1961a, p.115).

PASK explains: "Its statistical characteristics do not change. In a non-stationary system the statistical characteristics do change" (Ibid).

3413

SYSTEM (Steady state)²⁾

A system that maintains a more or less general **constancy** of its main **processes** and **variables** throughout **time**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

A steady state system should not be confused with a static system. No static system could ever process anything, nor survive any disturbance.

Steady state systems are **dynamically stable**.

→ **Homeostasis; Steady state**

3414

SYSTEM (Stellar type)

→ **Stellar type System.**

3415

SYSTEM (Structure)^{2) - 3)}

"One overall system that integrates several systems that share some **variables** or interact in some other way" (Adapted from G. KLIR, 1991, p.58).

Or "a set of interacting **behavior** or **state-transition systems**" (KLIR, 1988, p.151).

KLIR adds: "The **subsystems** forming a structure system are often called its **elements**. When **elements** of structure systems are themselves structure systems, we call the overall system a **second-order structure system**. Higher-order structure systems are defined recursively in the same way... Different **categories** of structure systems are thus distinguished by their **orders** and by the type of their ultimate **elements**" (1991, p.58).

KLIR also shows how structure systems can be conveniently represented by block diagrams (p.59), and how the ordering of epistemological systems **categories** can be described by semi-lattices (p.69).

Connecting the behavioral and state-transitional aspects of the system, KLIR reaches the epistemologically highest **level** in the **hierarchy** of inquiring **methods** that he proposed, in relation to his **reconstructability analysis**.

It is clear that he understands "structure" as a **set** of **diachronic** and interconnected **transformations**.

3416

SYSTEM (Symbolic)^{2) - 3)}

"A **concrete system** some of the **components** of which represent other **objects**" (M. BUNGE, 1993, p.212).

BUNGE gives **languages** as examples of symbolic systems. He extends however the definition as to cover: "... books, tapes, diskettes, blueprints, maquettes, toys, etc. On the other hand a stray **symbol**, such as a road **sign**, is not a system, though it may eventually become the founder of a symbolic system" (Ibid).

3417

SYSTEM (Teleogenic)^{1) - 2)}

"A system capable to generate its own **goals**" (N.A. COULTER Jr., 1968, p.35).

COULTER, Jr. gives the **brain** as an example: "A **brain**... has been designed by **evolution** to survive in an uncertain and sometimes hostile **environment**. In contrast to a computer, a **brain** is a teleogenic system... While under some conditions a **brain** may be controlled by outside **goals** or forces, it necessarily includes a self-determined **component**" (Ibid).

This was written in 1968, when the more precise concept of **organizational closure** of the **whole** (and not merely the self-determined **component**) was not yet well known.

3418

SYSTEM (Trivial)²⁾

A system whose **behavior** does not change significantly in **time**.

Its behavior is thus highly predictable.

Such a system is not learning by **experience** and is generally submitted to tight **controls**.

Most simple man-made systems were **trivial**, being submitted to also simple **regulators** or **controls**. New man-made systems tend however now to become **non-trivial** through the introduction of **meta-controls** and/or **learning** devices, as for ex. back- **propagation** in complex controlling **networks**.

→ **Artificial life; Network (Parallel processing); Parallel Distributed Processing; Trivialization**

3419

SYSTEM (Ultrastable)²⁾

W. R. ASHBY thus describes the ultrastable systems **behavior**: "(it) acts selectively towards the **fields** of the main **variables**, rejecting those that lead the representative point to a **critical state** but retaining those that do not" (1958, p.91).

In other words, the ultrastable system remains within the **limits** of a **basin** or **vicinity** defined by a stable attractor.

3420

SYSTEM (Viable)^{1) - 2) - 4)}

A system capable to maintain its independent existence (Adapted from St. BEER, 1989, p.11).

The Viable System Model has been introduced by S. BEER from 1966 on. At that time he wrote:

"Viable systems have the ability to make a **response** to a **stimulus** which was not included in the list of anticipated **stimuli** when the system was designed. They can learn from repeated experience what is the optimal **response** to that **stimulus**. Viable systems grow. They renew themselves... They are robust against internal **breakdown** and **error**. Above all, they continuously adapt to a changing **environment**, and by this means survive – quite possible in conditions which had not been entirely foreseen by their designer.

"Now the systems that must be handled in the economic, social and industrial worlds are indeed systems of such viable characteristics, which tend to have (when they are successful) the properties just listed. Cybernetics has demonstrated that they have these properties *only if* they have high **complexity**; they must exist beyond a certain '**complexity barrier**' to be viable" (1966, p.256).

BEER progressively developed the complex cybernetics involved in the Viable System Model. Hereafter a very condensed summary of the VSM. However, no summary can satisfactorily resume this complex work. For a full development, see "The Heart of Enterprise" (1979).

A Viable System is made of five types of interconnected systems at different **levels**.

"**Systems One**" are frequently numerous in a **complex system**. Each one attends a specific **process** related to a specific part of the active **environment** of the system.

"**Systems Two**" are coordinating **metasystems** of Systems One, which have anti-**oscillatory effects**, or act as "**input attenuators**", locally and globally (p.176-7).

"**Systems Three**" are concerned with the general **coordination** and **coherence** between Systems One and Two (p.205-7).

"**System Four**" responds to the need to cope with a larger **environment** and an unknown future. It aims at giving a wider **space (environment)** and **time (planning) frame** to Systems Three to One. To operate correctly any System Four needs to have access to the full **variety** available in Systems One to Three (p.349).

"**System Five**", in accordance with ASHBY's **Law of Requisite Variety**, must contain general **models** of Systems Three and Four in order to be able to **control** through general **closure**, if possible, unexpected external **variety** (p.352).

Unfortunately, System Five, as a "general boss" (individual or collective) is always in danger to become an autocratic power, "that will soon or later make a global mistake". (A possible way to avoid this could be the **heterarchical organizational model**).

While basically a model for the practical uses of **management**, the VS Model represents the **operation** of complex systems in general.

BEER's VSM relies heavily on two very basic cybernetic concepts: ASHBY's **variety** and MATURANA and VARELA's **organizational closure**.

Also unfortunately, the VS Model seems to be very difficult to assimilate for people who lack at least a global **understanding** of evolved cybernetic concepts, i. e. not merely WIENER's "**Communication and control**", or not even these! This leads easily to an "implementation syndrome" (p.442-3).

3421

SYSTEM (World) ⁴⁾

"The human supersociety composed of all the human societies" (M. BUNGE, 1993, p.213).

M. BUNGE makes the following suggestive comment: "The world social system was born on October 12, 1492. By the 18th century it was in full economic swing. By the time of World War I, it had also become a political system, albeit not a cohesive one. World-wide integration is still in the making" (Ibid).

It may be viewed as a **network** in course of creating myriads of new **interaction links**, possibly on its way to become a planetary **autopoietic system**. But there is a rock-bottom necessity: to become integrated within the planetary **environment** as a **whole**.

→ **Spaceship Earth**

3422

SYSTEM DESIGN ^{1) - 4)}

Any **method** aiming "at the construction of a **model** or a "blueprint" of a system to be developed" (B. BANATHY, 1973, p.89).

J.van GIGCH states: "The creation of any **artifact** requires a deliberate thinking **process** which is called *design*. It involves three main components: 1) the appraisal of *reality*, 2) *modelling* and 3) *metamodeling*" (1992, p.1).

According to BANATHY, who promotes the **concept**, systems design "aims at the construction of a **model** or a "blueprint" of a system to be developed" (1960, p. 89).

Such a design should be co-participative among all the interested people. It progresses through exploration of the possibilities, the search for innovations and a constant search for renewed **consensus**.

One of the most difficult aspects of system design is the search for and the discovery of hidden or ignored aspects of the situation which motivates the design. (see "**invisibility**").

Another is the dubious character of any **long-term forecasting**, due to the natural **turbulence** of any **environment**, which leads easily to **chaotic** conditions.

BANATHY himself states that "System development involves the formulation, testing, revision and validation of the system" (Ibid) (i.e., the blueprint and the system itself during its build-up).

→ "**Design (Systems)**" and "**Design (Systems Approach to)**".

3423

SYSTEM ENTITY STRUCTURE ^{2) - 5)}

A taxonomic **structure** employed to classify the various possible ways to modelize **complex systems**.

The "System Entity Structure" has been introduced by B. ZEIGLER (1984 and 1994).

In H. PRAEHOFFER's words: "The system entity structure is used to manage a family of **models** and has to support the **representation** of **decomposition**, **couplings** and **taxonomy**. **Decomposition** is used to represent the way real systems are composed into **components** in a **hierarchical** manner. **Coupling** specifications define how these **components** can be coupled together. Taxonomic **knowledge** means the **representation** of different kind of **objects** (i.e. how they are **categorized** and subclassified)" (1991, p.301).

This is a good **methodological** track, well adapted to conventional **computers** and based on the classical view of systems as pre-ordained **hierarchies** of **components**. The key word is here obviously "**decomposition**", with its somewhat **reductionist** overtones. But what about **networks** **representation** of **parallel learning** systems?

ZEIGLER defines the structure as a labeled **tree**, in accordance with the following axioms (as resumed by PRAEHOFFER):

"1. **Uniformity**: Any two **nodes** that have the same name have identical attached **variable** types and **isomorphic subtrees**

"2. **Strict hierarchy**: No **label** appears more than once down any **path** of the **tree**

"3. **Alternating mode**: Each **node** has a **mode** that is either entity, aspect, or specialization; if the **mode** of a **node** is entity, than the **modes** of its successors are aspects or specialization; if the **mode** of a **node** is aspect or specialization, then the **modes** of its successors are entity. The **mode** of the root is entity.

"4. **Valid brothers**: No two brothers have the same **label**

"5. **Attached variables**: No two **variable** types attached to the same item have the same name.

"6. **Inheritance**: Every entity in a specialization inherits all the **variables**, aspects, and specializations from the parent of the specialization...

"The best way to represent an entity **structure** is by a pictorial **representation** of the **tree structure**. The **nodes** of the **tree** represent entities, aspects and specializations. The **arcs** of the **tree** represent the relations between parents and their children. As, depending on the type of the **node**, we can identify different relations between the **nodes**, we use different **arcs** to represent these relations. An aspect relation is depicted by a single **line**, a multiple **decomposition** relation by three parallel **lines** and a specialization relation by a double **line arrow**" (Ibid., p.302-303).

It would be of much interest to evaluate FORRESTER's **systems dynamics models**, and other types of formalized **models** in the light of ZEIGLER's **methodology**.

Another good subject for research should be the **constraints** imposed by the nature of **digital** sequential **computer** on the **methodologies** of **complex systems modelization**.

For **graph** terminology, as used here, see "**graph**" and "**graph theory**".

3424

SYSTEM SPACE ^{1) - 2)}

"... the **domain** that the system occupies as defined by its **boundaries**" (B. BANATHY, 1973, p.89).

It should possibly be advisable to speak about the system **space-time**, in order to convey better the idea that the system is by necessity a **dynamic** entity. Furthermore, through **time**, the system space may well expand or contract.

3425

SYSTEMATICS (Evolutive) ²⁾

A general **taxonomy** of living **organisms** (Derived from LINNAEUS's "Systema Naturae" by later evolutionists).

Of course, "systematics" is to be clearly distinguished from "**systemics**", while a systemic concept pervades any **classification** by reference to **form** and **function**.

The evolutive **paradigm** historically confirmed the extension of systematics to fossils and gave it a **time** dimension which was lacking in LINNAEUS work.

Nowadays, many biologists adhere to other types of **taxonomies**, as a result of the difficulties of **consensus** on **criteria** of **classification** of **complex systems**: that which is readily observable is not necessarily fundamental.

→ **Cladistic analysis**; **Classification**; **Cluster**

3426

"SYSTÈME GÉNÉRAL" (Diagram of the) ²⁾

J.L.LE MOIGNE proposes a general **model** of system, which he calls "Système Général" and whose diagram he characterizes as follows:

"...An **object**, in an **environment**, endowed with **finalities**, which engages in an **activity** and whose internal **structure** undergoes an **evolution** through **time**, without however to loose its unique **identity**:

"In a more trivial way, but possibly easier to remember:

- *something* (anything that can be identified)
- which *do* something (**activity** = **function**)
- and which, endowed with a *structure*
- *evolves* in **time**
- *within* something (**environment**)
- *for* some reason (**finality**)

or, yet:

- an object active within an **environment** structured in relation to some evolving **finalities**" (1977, p.37).

We should however take time to reflect seriously about the meaning of terms like **structure** or **finality**. It would also probably be better to avoid the term **evolve** and speak of **adaptive transformations** for the systems which maintain their **identity**.

3427

"SYSTÈME GÉNÉRAL" (Structural matrix of the)²⁾

According to J.L. LE MOIGNE, the "Système Général" model is "a **net** marked off an **environment**". (The **net** is made of interconnected **processors**).

These interconnections are specified, and can thus be represented by a **matrix**, which reproduces the global **structure** of the system. It is also possible to figure it by a **graph**, in which the internal **processors** of the system are enclosed within a **boundary**, even if some of them are connected with external **sources** from which the system obtains its **inputs**, or with external **sinks** which receives its **outputs**.

This **model** should be compared with J.G. MILLER's one (1978), with G. KLIR's one (1990) and with those of J. FORRESTER (1961)

3428

"SYSTÈME GÉNÉRAL" (Theory of the) (J.L. LE MOIGNE)^{1) - 2) - 3)}

J.L. LE MOIGNE states unequivocally that, in his opinion: "The theory of 'the' General System is the theory of **modelization** of the **objects** (natural or artificial, complicated or complex) by way of this artificial **object** slowly shaped by the human mind, that L. von BERTALANFFY did propose to call the General System: a system which is a **model** of a general nature".

LE MOIGNE adds: "This artificial **object** is apt to be defined: it is possible to endow it with properties, it is possible to verify the **coherence** of these properties, it is possible, finally to use it in order to represent... other **objects**" (1977, p.36).

In J.C. LUGAN words: "This 'système général' integrates in a formal way a conjunctive axiomatics" (1993, p.92) (as opposed to the disjunctive one expressed by the **separability axiom**). It establishes a general formalism for the modelization of complex **phenomena**.

While this concept is, for sure, quite useful, it is very different of what "numerous anglo-saxons authors understand as "General System(s) Theory" – which may be translated in French by "Théorie Générale des Systèmes" and which gathers by progressive aggregation a great number of concepts and **models** related to **complex systems** (and, more recently to those systems called **composite** in this work).

3429

SYSTEMIC METHODOLOGY for STRATEGIC MANAGEMENT (SM: SM)⁴⁾

This methodology is proposed by R. RODRIGUEZ ULLOA, (Instituto Andino de Sistemas, Lima, PERU), in the following terms:

"Briefly, SM:SM is composed by five modules:

"a. The Efficacy and **Efficiency** Criteria System (EECS): Which defines, sets and considers efficacy and **efficiency criteria** under which all the **strategic change** will be monitored and controlled

"b. The Providing **Resources** System (PRS): Which obtains and provides for all kinds of **resources** to the **problem-solving** system at any time...

"c. The Social Research System (SRS): Aimed at detecting an **organization's** strengths and weaknesses

"d. The Organizational Policy Proposal System (OPPS): Oriented to define the present and future **organizational** mission and the **paths** (**strategies**), **means** (**resources**), timing and **management** style to achieve global **strategic change**

"e. The Implementation Organizational Policy System (IOPS): Aimed to disseminate, motivate, execute, supervise and control the global **strategic transformation process**" (1993, p.235).

SM:SM is actually used in **development** projects in Peru.

3430

SYSTEMIC PROPERTIES: a tentative listing¹⁾

- A **whole** is more than the sum of its **parts** (it includes the **interactions** of the **parts** and their possible multi-functionality)
- A **part** may have different **action potentials** in different systems (H in NH₄, or in HCl).
- A reliable system can sometimes be made of unreliable, but interacting parts (von NEUMANN)
- A **whole** tends to maintain a specific and a **dynamic stability** in **time**, by being adaptive.
- In a **whole**, internal **relationships** are frequently organized in **networks**.
- Internal **networks** are dynamic and adaptive through multiple **simultaneous** and repeated **feedbacks**.
- **Adaptiveness** remains constrained within defined **limits**, frequently in a cyclical way (**limit cycles**).
- A **whole** is autonomous in relation to its specific **environment**, i.e. is able to determine within **limits** its **relationships** with it (for ex. Internal temperature **regulation** in mammals; or **Inputs** and **outputs flows** in an enterprise).

- A **whole** can associate with others and build **wholes** of higher **complexity** (Fusions between enterprises, the European Union)

Generally speaking, systemic properties conform a set of correlated **explanations**, useful to describe integrate **behavior** in **entities** and **issues** made of numerous interacting **elements**, as contrasted, but also complementary to the more classical **analytic approach**.

3431

SYSTEMIC RISK¹⁾

Any risk which specifically results of the **complexity** of a system.

The specific risk is an ever possible consequence of some unadverted **instability** within the system, due to some architecture error if man-constructed, or more exceptionally of some inherent property in a natural system.

Man-constructed systems, when complex, are very difficult to fully understand and to manage properly. Furthermore, they are generally more or less unstable (submitted to **chaotic determinism**).

Natural systems may contain unknown **long-term instabilities**, as for example in the case of geological faults activity.

In **human systems** a supplementary factor of risk is the ever latent possibility of operative or **management** errors that may trigger a catastrophic course.

3432

SYSTEMIC THINKING^{1) - 3)}

A general approach to scientific inquiry that is specially interested in the study of **complex situations** and **systems**, using specific concepts and **models**.

Back in 1941, A. ANGYAL was already comparing the causal way of thinking with the systemic one, in the following terms: "In causal research, the task is to single out from a multiplicity of **data**, pairs of **facts** between which there is a necessary **connection**. In systems thinking the task is not to find direct relations between members but to find the **superordinate system** in which they are connected or to define the **positional value** of members relative to the **superordinate system**" (1941, p.24).

He added: "One thing... seems clear, namely that systems cannot be deduced from **relations**, while the deduction of **relations** from systems still remains a possibility. If that is the case then the more general logical genus would be 'system', while 'relation' would be a reduced, simplified system which is adequate only for the logical presentation of very simple specialized constellations" (Ibid., p.25).

This viewpoint seems however somehow contradictory with the concepts and **methods** of KLIR's **reconstructability analysis**. The ideas which seem to be lacking here are those about *relations between relations* and *relations inbetween levels*.

From a different viewpoint, M. BUNGE writes: "Some systems theorists believe that **systemics** belongs in mathematics. I submit that this opinion is mistaken, because, unlike pure mathematics, **systemics** is about real things. (**Systemics** has a mathematical formalism but a factual content). Others seem to believe that **systemics** is a mushy popular philosophy, rehashed romantic talk about unanalyzable **wholes**. This opinion too is mistaken, because **systemics**, unlike **holism**, analyzes systems, and furthermore it does so with the help of mathematics – a *bête noire* of all romantics" (1979, p.221).

It should be observed however that systemics uses evermore new mathematical tools of, at least, a partially qualitative character.

3433

SYSTEMIC/Holistic versus NONSYSTEMIC THINKING¹⁾³⁾⁴⁾

M. MULEJ and his colleagues and collaborators at the Faculty of Economics, University of Maribor, Slovenia, resume in the following listing the characteristic differences between these two ways of thinking (2002)

Systems/Systemic/Holistic Thinking	Unsystemic, Traditional Thinking
Interdependence/s, Relation/s, Openness, Interconnectedness	Independence, Dependence, Closeness
Complexity (plus Simplicity, or complicatedness)	Complicatedness
Attractor/s	No influential force/s, but isolation
Emergence	No process of making new attributes
Synergy, System, Synthesis	No new attributes resulting from relations between elements
Whole, holism, big picture	Parts and partial picture attributes only

They proceed by describing the **attributes** of the various terms and expressions used (all of these in this Encyclopedia)

The authors also underline that systems thinking is different and in some sense wider than **systems theory** (or theories), which is "an abstract generalization of the practical attributes of systems thinking, or a **description** of complex **entities** called systems" (Ibid)

The paper includes also some historical information and concludes that "systems thinking based on a **realistic** systems theory may be

able to help humankind find a new way toward **survival**".

3434

SYSTEMICS^{1) – 3)}

An open **set** of concepts, **models** and practical tools useful for a better **understanding** and eventual **management** of complex **situations** or entities of any type.

It would seemingly be advisable to replace expressions like "**Systems Research**", "**General Systems Theory**", "**General Theory of Systems**", or "**Systems Science(s)**" by the word "**Systemics**". In this way many **ambiguities**, sterile controversies and in some cases, inflated claims could probably be laid to rest.

According to M. BUNGE: "Because of its generality it has a sizable overlap with **ontology** and metaphysics construed in the traditional pre-Hegelian sense, as well as in our own sense of scientific **ontology**. Both systems experts and ontologists are interested in the properties common to all systems irrespective of their particular constitution, and both are intrigued by the peculiarities of extremely general theories, which are methodologically quite different from specific theories" (1979, p.3).

Generally speaking, systemic **models** "have sought to restaure multidimensionality to our world views and **modes of inquiry** (M. DODDS and G. JAROS, 1994, p.9).

Furthermore, systemics, combined with cybernetics, has introduced new concepts and **models** of **nonlinear** complex **processes**, as for example **catastrophes**, **deterministic chaos**, **dynamic stability**, **dissipative structuration**, **feedbacks**, etc.

A more specific aim of systemics is stated by H. PRAEHOFFER: "... an **interdisciplinary** discipline that tries to provide general concepts for **model building** and **problem solving**" (1991, p.290).

As noted by M. BUNGE: "Systemics has two related motivations, one **cognitive** and one practical" (quoted by M.C.LE DUC, 1992, p.916).

N. PEGUIRON observes: "Systemics appeared – one could say – progressively, as a reply to a new awareness of a varied mixture of discoveries:

- **indeterminism** in classical mechanics.
- the incapacity, in spite of an even deeper **knowledge** in the classical senses, to explain in pluricellular living beings, the **phenotype**, starting from the **genotype**.
- a great difficulty in modeling complex **evolution** in **ecology**, and also the discovery of the limited character of that **ecosystem** which sustains human **activity**.

"On the scientific level, systemics appeared as a result of some new disciplines, which it assembled in a study of those matters that science could not yet explain" (1989, p.6)

Among these new disciplines or theories, PEGUIRON cites:

- **Thermodynamics of irreversible systems** out of **equilibrium**.
- **Catastrophe theory**.
- The concepts of **strange attractors** and **chaos**.
- The theory of **fractals**.
- We may add, among others:
 - at least three different **understandings** of what is **autonomy** (BERNARD/CANNON/VEDRYES; ASHBY; MATURANA/VARELA)
 - the concept of **autopoiesis**
 - new ideas about **cycles** and **cyclical behavior**
 - the **cybernetics** of **feedback**, **regulation**, **control**, **variety** and **constraints**
 - the theory of the **observer**
 - some consequences of **relativity (simultaneity in different referentials)**.

This "toolbox" of conceptual **models** is becoming ever more useful for the study of all kinds of **complex systems** in neurology and **brain studies**, **information** and **communication** sciences, behavioral sciences, **ecology**, economy, social sciences, **management**, etc...

All of the listed notions are related, not to out-of-context phenomena but on the contrary to interconnected ones, generally within complex specific settings and constrained by not necessarily **stable** conditions. Accordingly, systemics abandons the "... *et ceteris paribus*" clause.

The global goal of systemics is thus defined by J.C. LUGAN: "(Systemics should) replace the disjunction-reduction paradigm by a **distinction-conjunction** one, which should allow **distinction** without disjunction and **association** without identification or **reduction**" (1993, p.113).

It should be stressed that systemics is not merely a **systematics** of ideas, as for example some philosophical "systems" of ideas. While Cl. BERNARD said that "Systems are not in nature, but in men's heads", it should be understood that they reflect somehow reality. Here is the basic clivage between systemic **understanding** of **behavior** and **structure** of "something out there" or rigid and systematic **models** created once and for all by a self-limiting **mind**. There is nothing wrong with systematics, but it refers to **taxonomics**, **classification** and highly abstract **constructs**, quite disconnected from anything concrete.

On the contrary, systemics cannot be reduced to a more or less limited compendium of cognitive recipes and their products.

M.C.LE DUC is probably right saying that "... **constructivism** emphasises the **process** of working back and forth between our mental world and the concrete world". Consequently, he proposes the following axioms for systemics:

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"1. There is a *concrete world* around us that is accessible to our *mental world* only by the mental **structures** already in the mental world.

"2. New mental **structures** are **constructed** from existing ones to enhance the *fit* between the mental world and the concrete world (PIA-GET)

"3. Mental **structures** are organized into **levels**, some of which have **emergent** properties" (1992, p.917).

For interesting historical data and philosophical comments, see also R. RODRIGUEZ DELGADO (Chap.2 and 3) (1997)

→ "**Structural differential**".

3435

SYSTEMICS in Latin America ¹⁾

There are two systems societies in constant activity in Latin America: one is the **Argentine Association for General Systems Theory and Cybernetics** (also known as GESI (Group for the Study of Integrated Systems) active since 1976. The other is the **Instituto Andino de Sistemas** in Perú, created in the 1980's (see the corresponding entries)

There are however other informal groups, which produce original work. In Argentina Prof. Enrique HERRSCHER created in 2001 the Center for Systemic Action and Thinking (CAPSIS in Spanish abbreviation), in collaboration with ACKOFF's Interact Institute. CAPSIS organizes research, teaching, events, and cooperates with various systems associations. Herrscher and collaborators published a book in Spanish: "Pensamiento Sistémico" in 2003. (see bibliography)

At the Universidad de los Andes, in Mérida, Venezuela, Prof. H. LOPEZ GARAY and R. FUENMAYOR elaborated what they call **Interpretive Systemology**.

Another group is at the Technological Institute of Monterrey, Mexico, where Prof. R. CARDENAS forwarded **Generic Design** after her collaboration with Prof. John WARFIELD.

In São Paulo University, Brazil, another team, under the leadership of Prof. Dante MARTINELLI, developed a School of **Management** in systemic terms.

And even if they worked for many years in North America and Europe, it should not be ignored that Humberto MATURANA and Francisco VARELA were as Chileans, the founders of the so-called **Santiago Theory** (being Santiago de Chile, the name of the Chilean capital)

Other scholars in Chile, Mexico, Colombia and Venezuela have also produced interesting work.

It is even quite possible that some Latin American scholars in the field are still unknown to this editor, considering the quite imperfectly developed scientific communications in this

huge and geographically very fractured continent, and some lack of practical operativeness of the Asociación Latinoamericana de Sistemas (ALAS), because of very scant funding.

3436

SYSTEMICS in Switzerland ¹⁾

There are two main centers in Switzerland where systemic and cybernetic **concepts** and **models** have received a sustained attention and generated original work of great interest.

The first one is the School of Business Management at the University of Sankt Gallen. During the 1970's and 1980's, Prof. Hans ULRICH and Gilbert PROBST developed original ideas about **self-organization** as a way for the **management of social systems**. They also insisted on the necessity of global views for managers confronted with organizational **issues** and **decision making**.

More recently, Prof. Werner ULRICH has consistently explored issues in **social design** and **planning**. He developed what he calls "Critical heuristics" as a tool to be used in this field.

Prof. Markus SCHWANINGER explored in recent years the possibility and characteristics of intelligent organizations and the conditions for integrated business enterprises planning, specially **competence in understanding** and managing **complex issues**. He sees a kind of ecological dimension in organizational intelligence.

The other center much interested in systemics is in the French speaking part of the country. A quite significant work is constantly forwarded at the Association F. Gonseth, Institute de la Méthode in Bienne. (F. Gonseth has been an outstanding Swiss epistemologist of the 20th C. who introduced the concept of "**ideoneity**"). Consequently the attention of this group is centered on more abstract themes as for example: **representation**, the mind-body problem, **phenomenology**, **complexity**, **transdisciplinarity**, **perception**, **autonomy**, **constructivism**, **holism**, conceptual a priori, **truth** and **idoneity**, Popperian critical rationalism, **autopoiesis**, etc.

The Group organizes "written symposia" in which these themes are however discussed in a kind of conversational style. The debates are published in a periodic bulletin since more than 20 years and also in the "Cahiers de l'Institut de la Méthode". Among the most active participants are J.C. TABARY, a neuropsychiatrist; F. BONSACK prof. of philosophy, P.M. POUGET, prof. of philosophy, J.F. QUILICI-PACAUD, technologist, M.C. DUPRE, anthropologist.

Another participant is Prof. Eric SCHWARZ, of the Neuchâtel University. He is an active organizer of meetings and tutorials in Neuchâtel and Geneva, and a frequent author of papers centered in holism, **evolution** and other wide-embracing themes in cybernetic and systemic

terms. He created the "Centre Interfacultaire d'Etudes Systémiques" at his University.

3437

SYSTEMICS (Practical) ²⁾

D. DURAND emits the following "guidelines for a correct use of the systemic **method**" (1979, p.69);

- "5 "negative" guidelines
- not to reduce **variety** in order to simplify
- not to eliminate **uncertainty** or **randomness**
- not to ignore **constraints**
- not to cut **feedback loops**
- not to try to be exhaustive
- "5 heuristic type guidelines
- Favour a revealing **model** over an explanation
- Start with a **synchronic** approach, and follow with a **diachronic** one
- Think of **function** and **structure** alternatively
- Put emphasis on the systems **links**
- Put emphasis on the **regulation subsystem**
- "5 guidelines for **action**
- Define **goals**, better than establish a **program**
- Allow for **autonomy** at each **level**
- Use **information**, more than **energy**
- Take in account **delays** in **responses**
- Maintain **adaptation** margins".

While possibly somewhat too **systematic**, these guidelines are surely useful, and even basic for the **understanding** and the **management of complex situations**.

"**Information**" should include the complete "tool-box" of systemic concepts and **models**.

Systemics should, in the opinion of this compiler, never be considered in a prescriptive way. It could not justify any **ideology**. Such a deformation would become very confusing and dangerous.

3438

SYSTEMICS vs SYSTEMATICS? ^{1) - 2) - 3)}

Systematics is mostly an **arbitrary** mode of **classification**. One example would be arranging a collection of books according to the color of their cover.

However, some **classifications**, at first sight arbitrary, may finally reveal an underlying **general order**.

This was the case for example with MENDELÉEV's table of elements, whose regularities are consequences of the atomic **structures**, that were unknown at the time.

There may thus be a progressive shift from systematics to systemics as the apparently arbitrary **order** is found out to conceal an **algorithm**, which in turn reflects a general **mode of organization**, i.e. significant **correlations** or **interrelations** among the classified items. Such **relations** then become the groundwork for the study of **organized complexity**, i.e. **systemics**.

Systematics can thus be used as a **heuristic** tool in systemics. However, a previous general **understanding** of the systemic **paradigm** is necessary, in order to understand what to search for.

It is to be noted that a purely systematic view impairs many times the **perception** of systemic **order** and even leads to spurious orderings of **data**. Serious cases have been observed in economics and in experimental psychology, for example.

3439

SYSTEM-INQUIRING METHODS (a taxonomy of)^{1) - 2) - 3)}

For G. KLIR systems inquiry covers: "the full scope of activities by which we attempt to construct systems that are adequate **models** of some aspect of reality... (in order) to make adequate **predictions** or retrodictions, to learn how to **control** the **phenomena** in any desirable way, and to use all these capabilities for various ends" (1993, p.30).

KLIR tried to establish a "**taxonomy of systems**" that may possibly be better understood as a taxonomy of **methods** to establish **models** of systems (1988).

He defined the following ideas: we start with an "**experimental frame**", which determines what precisely we are going to register, defining the limits of our inquiring. The basic element in this experimental frame is a "**mask**", i.e., a partialized screen through which we select and observe **states** and **processes**.

Using this basic inquiring device, we define a "**source system**" as a producer of empirical **data**.

Our **observations** usually lead us to the discovery of some "**type of activity**", characteristic of the **source system**. Such **activity data** can be referred to two different aspects of the system:

- The "**behavioral system**", corresponding to time-invariant relations.
- The "**state-transition system**", characterized by a **set** of overall **states**.

Integrating both aspects we obtain the "**structure system**", corresponding to a **set** of interconnected **diachronic transformations**.

→ "**Reconstructability analysis**".

3440

SYSTEM MASK

→ **Mask**

3441

SYSTEM-LEVEL EFFECTS²⁾⁴⁾⁵⁾

One of the most startling system-level effect is that an established system's dynamics may block invasions by new species, even those endowed with superior characteristics.

In Roger LEWIN's words: "The **network of connections** between the species of the mature **ecosystem** protects those species from outside **competition**" (1997, p. 31)

This remains true until the existing **ecosystem** is deeply perturbed, with a considerable disorganization of the **interrelations network**. In such a **situation**, a sudden **collapse** becomes possible.

According to LEWIN, such effects can also be observed in economy: New firms, even with a superior product, could be unable to introduce themselves in the productive circle, due to a kind of global inertia of the existing system.

The disorganization of an **ecosystem** (biological or otherwise) is frequently a progressive **process** and the **collapse** occurs only at a **critical stability threshold**. Some oceanic **ecosystems** have been thus affected in the recent years and one may wonder if similar effects cannot appear in economic and socio-political systems.

3442

SYSTEMOGENESIS¹⁾²⁾

The progressive construction of successive **emergent levels** of **complexity** produced by antagonically interacting **fields**.

When the same **interactions** become repetitive, more or less permanent **processes** appear, which in turn may lead to materialization of more or less permanent **structures**, i.e. **forms**. The concept has been introduced by S. LUPASCO and is based on his **Antagonism Principle**, which in turn results of the combination of **energy dynamics** (as stated in the 2nd Principle of thermodynamics) and PAULI's **Exclusion** principle, which leads in fact to individualization of **elements** (see bibliography)

In different, but equivalent ways, the subject has been tackled by d'A.W. THOMPSON (1916), Ch. LAVILLE (1950), D. McNEIL (1993b), and V. CSANYI (1982, 1989)

→ **Autogenetic systems precursors; Zero system**

3443

SYSTEMOGRAPHY²⁾

"The creation of **models**, **isomorphic** to the "**Système Général**" (J.L. LE MOIGNE, 1977, p.54).

This neologism was introduced by LE MOIGNE to refer to the uses of his "**Système Général**" model.

According to him we should try to "escape from the **semantic contradiction**" in the current expression "**Systems Analysis**" (1977, p. 43).

LE MOIGNE clearly perceives that the **concrete systems** or **objects** are never **isomorphic** with their **models** (nor with each other), but only **homomorphic**, up to a point.

Only the **models** can be **isomorphic**, as the modelizer do construct them according to his intentions, a fact which LE MOIGNE acknowledges as follows: "... every **object**, every aspect of any **object**, in our opinion, is not evident, but merely pertinent in relation to the intention that we lend to it" (p. 55).

He also quotes G. PASK: "Any **pattern of activities** within a **net**, if coherent by some **observer**, is a system" (1960, p. 233).

3444

SYSTEMOLOGY^{1) - 2) - 3)}

A reformulation of so-called **system sciences**, proposed by D. Mc NEIL.

The term was initially proposed by R.L. ACKOFF in 1973: "As the problem complexes with which we concern ourselves increase in **complexity**, the need for bringing the **interdisciplines** together increases. What we need may be called **metadisciplines**, and what they are needed for may be called **systemology**" (1991, p.33).

The basic tenet of Mc NEIL's proposal is that all systems are basically **toroids**, i.e. complex structured **torus**. This is consistent with C. LAVILLE's general concept of **energy vortexes** (1950).

According to Mc NEIL "... no system – properly so-called – can be represented by any less a figure than a three dimensional, **homeokinetic torus** within a **flux of throughput**... At a given **echelon of order**, a system is a **dynamic, organized, delimited, open, persistent, composite whole**. It is **voluntary**, comprising at least one **loop** and at least one **link** which manifest the aspects of **content, form, function** and **control**, together with **timing** and **scaling** factors, relative to an **environment** and relevant to a percipient" ("Percipient" can be viewed as a synonym for "observer", with possibly a shade of GIBSON's way to understand **perception**).

He adds: "The **paradigm**, illustrated as above, offers an organized, constitutive core of systemological **concepts** accessible "by inspection". Having placed the visualization of a systemological **paradigm** into a **toroidal context**, one can proceed to explicate related concepts such as **boundaries, interfaces, stability, succession, trajectories, chirality, polarity, potential, reciprocity, complementarity**, etc... At the same time, a **frame of reference** is established for systemic principles such as conservation, **equipotency, requisite variety, parsimony**, and mutuality... Throughout all of this, the percipient remains pivotal because there is no system – properly construed – except as it is **defined** relevant to **purposes**. By attending to the **toroidal whole**, this systemological **paradigm** accommodates the "real"

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

world which is assured to exist regardless of what any percipient may think as well as the "imaginary" world out of which come the thoughts which define and alter reality".

And "Clearly, a systemological **paradigm** turns many a conventional **worldview** inside-out. To adopt and assimilate it is to re-cognize the world from the **linear**, the **convex**, the **closed**, the **cropped**, and the **particulate**... into the **cyclical**, the **hyperbolic**, the **open**, **continuous** and **vorticate**" (1993).

Mc NEIL's basic paper is profusely illustrated, which makes the understanding of all these statements very clear and easy.

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SYSTEMOLOGY (Interpretive)

→ Interpretive systemology

3446

SYSTEMS AGE ¹⁾ - 4)

According to R.L. ACKOFF, (as quoted by M.C. JACKSON, 1992, p.145): "About the time of World War II, the "machine age" - associated with the industrial revolution - began to give way to the "systems age". The systems age is characterized by increasingly rapid **change**, **interdependence**, and **complex purposeful systems**. It demands that much greater emphasis be put on **learning** and **adaptation** if any kind of **stability** is to be achieved. This, in turn, requires a radical reorientation of worldview. Machine-age thinking - based upon **analysis**, **reductionism**, a search for **cause-effects relations** and **determinism** - must be complemented by systems-age thinking, which proceeds by **synthesis** and **expansionism**, tries to grasp producer-product **relations** and admits the possibility of free will and **choice**".

Nowadays, many more characteristics of systems age are emerging as for example general and special **networks development**, a clearer view of **time dimension** in natural and **human systems**, the discovery of the critical relation of **human systems** with their specific **environments**, a better **understanding** at the same time of the **constraints** related to **auto-poiesis** and of the concomitant acquisition of individual and **group autonomy**, etc...

3447

SYSTEMS ANALYSIS ¹⁾ - 2) - 3)

1. "The procedure of studying systems by identifying their **limits** and **parts** (**subsystems**), their aims, programs and effectiveness (O.R. YOUNG, 1974, p.299)

2. "Study and analysis of complex problems in terms of the **relations** between the **subsystems** that form its **component parts** with the **objective** of predicting the **behavior** of the **whole** from that of its **parts**" (UNE Glossary, 1983, p.26)

3. "The **diagnosis**, formulation, and solution of problems that arise out of the complex forms of **interaction** in systems of any kind" (Adapted from K. KRIPPENDORFF, 1986, p.74).

4. "An analysis to suggest a course of **action** by systematically examining the **costs**, **effectiveness** and **risks** of alternative politics or **strategies** - and designing additional ones if those examined are found wanting" (E.S. QUADE, 1963, as quoted by M.C. JACKSON, 1992, p.75).

Systems analysis developed out of wartime military operations (1940-45) and was later extended to the study of **complex systems** in general, notably through the RAND Corporation (set up in 1947).

According to M.C. JACKSON: The **methodology** of systems analysis can be seen as consisting of seven major steps, as follows:

- Formulating the **problem**

- Identifying, designing and screening alternative **responses**
- Building and using **models** for predicting the consequences of adopting particular **responses**
- Comparing and ranking alternative **responses**
- Evaluating the analysis
- **Decision** and implementation
- Evaluating the outcome" (p.76)

Systems analysis is basically oriented to technical systems **planning**, generally without participation of most **stakeholders** and scant consideration for the ways they are affected by the **design**.

KRIPPENDORFF states that this **methodology** is applicable "from hardware to corporations" whose aim is "to accomplish one or more specific **objectives**". Furthermore: "Systems analysis provides a **variety** of analytical tools, **design methods** and evaluative techniques to aid in **decision making**..." (Ibid).

I.G. BLOOR writes: "Systems Analysis covers such a computer-related technique which really bases its principles on Organization and Methods" (1987, p.55). This is of course a much reduced and sheer technical view of systems analysis.

According to J.de ROSNAY, in Systems Analysis one defines "the **limits** of the system to be modeled, identifies the most important **elements** and the **interactions modes** between these **elements**, determines the **linkages** that integrate them in an organized **whole**. **Elements** and **linkages** are classified and **hierarchized**. Next, one seeks and identifies the **flow variables**, the **state variables**, the **positive** and **negative feedbacks**, the **delays**, the **sources** and the **sinks**. Every **feedback** is segregated and its influence on the various subjects of the system is assessed." (1990, p.113). Accordingly to this view, systems analysis should be a preparatory stage for **systems dynamics** runs.

Systems Analysis defines the **data** to be used to build a **model** of the system. However, and unfortunately, in many cases, the **data**, when provided, are incomplete, insufficient or poorly assessed. G. KLIR's "**reconstructability analysis**" aims to improve systems analysis as a **method**.

For L. TRONCALE, systems analysis is the "most **reductionist** of **systems approaches**; the collection, treatment and **validation** of concrete **data** on the multiple **components** of a specific real system; ...often leads to **simulation** of the system for the purpose of quantitative prediction; results are **context-dependent**; ...does not focus on **isomorphies**; (it) relies heavily on the use of mathematical formalisms and the use of the computer; ...leads to usually restricted to the detailed study of one particular system (and) so it is less comparative across different cases, even within a conventional discipline, than **systems theory**; when it does involve **multi-disciplinary** comparisons, it focuses on one **problem**, or **design goal**, using one tool, as in the study of acid rain, or global climate" (1985, p.45).

In synthesis, the technical tool may well limit the vision of the **modelizer** and the scope of the enquiry.

Unfortunately systems analysis has produced in the fifties and the sixties "some exaggerated and highly oversold claims ... as a tool for making public policy" (G. KLIR, 1990, p.166). This situation led to strong criticism by I. HOOS (1972), D. BERLINSKI (1976) and R. LILIENTHAL (1978).

Still more unfortunately, Systems Analysis was frequently confounded with the **Systems Approach**, and as a result, the critique of the former one, in not a few cases, was extended in a superficial way to the latter one. One of the main sources of these negative appreciations has been the somewhat hyperbolic and imprudent use of J. FORRESTER's **Systems Dynamics** in the **Club of Rome** studies. For a balanced appreciation of these critiques see G. KLIR (1991, p.166-8).

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SYSTEMS ANALYSIS: Its basic categories ¹⁾ - 2) - 3)

Ch. HITCH, quoted by I. BLAUBERG et al. lists the following "universal logical elements of systems analysis", which BLAUBERG et al. consider to be **categories**:

1. A **goal** or **set of goals**
2. Alternative **means** ("systems") that can be used to reach the **goal** and are **sets** of systems **elements** or **strategies**;
3. **Resource** expenditures on the system;
4. A mathematical and logical **model**, i.e. a system of **connections** between the **goals**, alternative **means**, **environment**, and requirements imposed upon **resources**

5. The **criterion** by which the preferred alternatives are selected" (in BLAUBERG et al., 1977, p.265).

Obviously, systems analysis is "ad hoc": **goals, means, models**, etc... are selected by the analyst, in relation to his own **goals, knowledge** ... and prejudices, and also probably those of the user of the system. This is unavoidable, of course, but should preferably not remain unknown from the analyst, nor from his "client", nor shrouded from the view of other possible **stakeholders**.

3449

SYSTEMS ANALYSIS (Weaknesses in) ^{1) - 3)}

Systems Analysis suffers from various weaknesses. Some are methodological, others are conceptual.

As to conceptual aspects R. TOMLINSON and I. KISS state: "One... assumption was that the "hard" part of the problem – which could be expressed in mathematical terms – could usefully be isolated from the human and organizational **elements** which could thus be eliminated from the analysis. Another false assumption was that implementation was an entirely separate **activity** from the analysis itself" (1984, p.IX).

From a methodological viewpoint, complex **situations** and **nonlinear processes** are many times excessively simplified in order to allow for their study within the **framework** of current mathematics. H. LINSTONE writes: "The analyst has been caught between two unpalatable **choices**: solving **linear**, irrelevant problems and struggling unsuccessfully with **nonlinear** relevant ones" (1989, p.309).

Obviously, using correct mathematics to solve a ill-stated problem leads to illusory **forecasts** and to a false security.

3450

SYSTEMS APPROACH ^{1) - 2) - 3) - 4)}

In general

J.van GIGCH enumerates many different aspects of the systems approach, which "can be regarded as:

"A methodology of design

A common conceptual **framework**

A new kind of scientific **method**

A theory of **organizations**

Systems **management**

A method related to **systems engineering, operations research, cost effectiveness**, etc...

Applied **General Systems Theory**" (1978, p.34)

van GIGCH completes his overview establishing a **taxonomy** of sciences and systems, divided into "hard" and "soft" systems in physical, life, behavioral and social sciences (p.39).

Logical aspects

BLAUBERG, SADOVSKY and YUDIN consider that, from the logical viewpoint, "the development of systems research presupposes:

a) The construction of formal logical systems describing the **process** of reasoning as applied to certain aspects of the systems approach or special systems theories (e.g. the logic of **relations, bio-logics**, the logic of reflexive reasoning, etc...)

b) The formulation of the logical apparatus of the **general systems theory**

c) The metamathematical and metalogical analysis of systems formalisms" (1977, p.125).

Methodological aspects

According to the same authors, the methodological aspects of the systems approach "cover the following tasks:

"a) The explication (including the formal explication) of the basic concepts of the systemic approach, such as **system, element, connection, structure, wholeness, part-whole relation**, etc...

"b) The **classification** of systems, including the discussion and comparison of the various approaches to this problem

"c) The identification and analysis of the specific methods of **systems research** – the systemic (integral) **representation** of a system **object**, the investigation of a system together with its **environment**, the **isomorphy** of systems **concepts** and **laws, systems analysis** and **synthesis**, etc...

"d) The **methods** for constructing the theoretical **knowledge** of systems – both in the case of special systems concepts and in formulating a **general systems theory** (1977, p.125).

J. SUTHERLAND, from another viewpoint on **methodology**, proposed what he called the syncretic approach, "... to insure that the systems **models** we use comprehend to the fullest extent possible both qualitative and quantitative **constructs**" (Quoted from J.D. WHITE, 1977, p.68).

As to the basic nature and limits of the systemic approach, J.C. LUGAN writes: "The systemic approach consists in isolating a number of **elements** n, emphasizing certain types of **relations** that would give a degree of **autonomy** to the system in relation to a more extensive set N of **elements**.

"This global character of systemic **modelization** should not be understood as aiming at exhaustivity. To begin with only those properties considered as essential from the modelizer's viewpoint are taken in account. The **model** can be enriched... (but will never be complete). In other words, systemic **modelization** should tend to be an evolutive **process**, conscious of its limits between a kind of exhaustive perfectionism and an excessively reducing **simplification**" (1993, p.24).

Psycho-sociological aspects

E. HERRSCHER writes: "The point can be made that the systems approach comprises both rational and non-rational **elements**. Particularly since **soft systems thinking** took the lead from the hard system approach, many social, political and psychological **issues** became more relevant, weakening the rational part of the rational/non-rational mix or, at least introducing (in the words of C. FRANÇOIS) a psychical and sociological rationality, complementary to the hard systems approach. Few social scientists would object, but some quantitative or **closed-model-oriented** scientists might" (1995).

The systemic psycho-sociological rationality aspects are of different kinds:

1) The systemic inner and relational workings of societies; **autopoiesis, conflict, hierarchies, interactions** with the **environment; networks, processes, side effects, stigmery, subsystems**, etc...

2) The ways these inner social workings translate into attitudes, **situations** and **issues: values, norms, ideologies**, prejudices, power **relations**, etc...

3) The ways the **modelizer** understand (or not) his/her **observer role** and **choices** when **modeling** some social system, and perhaps his/her **relationship** with members of the latter, who required the intervention.

3451

SYSTEMS (Basic classes of) ¹⁾

G. BROEKSTRA compares two different basic classifications of systems.

In his opinion **closed systems**, wherein only the stable **relations** of the **parts** to the **whole** are considered, can be equated with mechanical (Newtonian) systems. In both case, the **control** is **exogenous** (or **algorithmic**).

Open systems are those in which **wholes** are necessarily related to a specific **environment**, and are fairly similar to PRIGOGINE'S **equilibrium systems**, "as dealt with by classical **thermodynamics**".

Finally, EHRlich and RAVEN's **co-evolving systems** are those whose **relation** to their changing **environment** is constantly evolving and can be compared with PRIGOGINE'S **non-equilibrium systems**, submitted to "... the principle of **order through fluctuation** (that) describes the **phenomenon** of spontaneous **structuration**" (1993, p.74).

Many other classifications have been proposed, considered from widely different viewpoints. Here are some:

- K. BOULDING: from simple "**frameworks**" to "transcendental systems" (1956).
- H.A. SIMON: considering specific systems characteristics in systems from physical to symbolic (1965, p.63-76).
- J. LESOURNE: taking in account a less or more developed degree of **organization** and **autonomy** (1976).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

- J.G. MILLER: His taxonomy of **living systems** based on growing **complexity** or **organization** through 8 **levels** (1978).
 - J.D.R.de RAADT: his multi-modal concept as a base for the characterization of systems on multiple **levels** from "numerical" to "pistic" (1989, p.17-25).
 - K. KORNWACHS and W.von LUCADOU: based on the degree of describability of systems (1989, p.125).
 - G. KLIR: his **epistemological systems hierarchy** referred to levels of **description** and related to his **reconstructability analysis** (1991, p.222 and 344).
- hereafter and "Systems types".

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SYSTEMS BEHAVIOR (Modifying) ^{1) - 4)}

The behavior of a **complex system** should be modified only according to a global perspective. Introducing any limited local **changes** will merely lead to their uncontrolled propagation to the whole system, sometimes with disastrous results. This is the key explanation of global disasters, as for example the Aral Sea one. The following systemic **norms**, intended to modify **complex systems** behavior, are adapted from P. BÜTTNER, as resumed by J. BRIGGS and F.D. PEAT (1991, p. 177, French translation used):

- In any system there is a very limited number of **trigger** points that can be used to produce significant and lasting modifications of the systems behavior
- In more **complex systems**, **effects** are more distant from **causes** in **time** as well as in **space**
- Even very few **feedbacks** within the system reduce much its **predictability**
- Neither the **trigger** points, nor the ways to operate on them are obvious
- Worsening of the system's behavior after an intervention frequently precedes any improvement.

A good **understanding** of all these points is a sine qua non condition for any hopefully efficient attempt at **management** of **complex systems**.

3453

SYSTEMS CINEMATICS ²⁾

According to J.L.LE MOIGNE and R. THOM, the label "**Systems dynamics**" applied by J. FORRESTER (1973) to his **models** is "very ambiguous".

R. THOM quoted by LE MOIGNE, writes: "... *A priori*, any **model** involves two parts: a **cine-matics** whose aim is to parametrize the **forms** or the **states** of the considered **process**; a **dynamics** whose aim is to describe the **evolution** through **time** among these **forms**" (1972, p.19).

In some sense these comments are concurrent with those of the author of this work, who thinks that FORRESTER's dynamics is rooted into some more or less implicit postulates about the system's nature and the permanence of its **interrelations** with its **environment** (Ch. FRANÇOIS, 1983).

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SYSTEMS (Co-operative) ²⁾⁴⁾

M. JACKSON comments on the co-operative system **model** introduced (in business **management**) by C. BARNARD as early as 1938 (2000, p. 108)

Basically, cooperative systems appear when **groups** of individuals share common **goals** and are **simultaneously** submitted to similar **constraints**. They quickly find out that by sharing **resources** and harmonizing **behaviors** it becomes possible to attain their goals more easily and more economically.

"Sharing" and "harmonizing" imply the need and the shaping of differentiated **structures** and **functions** and, of course, of a general **co-ordinator** and **regulator** of the **subsystems** activities as related to the basic goal of the system (which is **survival** in the most efficient way).

Jackson writes: "Barnard believed his thinking was relevant to all forms and types of **organization**. His aim was to discover features common to executive **functions** in all organizations". Obviously, these basic executive functions are precisely coordination and regulation. But the previous and indispensable condition is a sound **understanding** of the general nature and order of the co-operative systems.

It is useful to note that these functions exist also in a much less specific way in animal and specially insects societies and are now also emerging in **robots** endowed with reciprocal capacities of **communication**.

→ **Artificial life; Communication; Control; Decision making; Herd effects; Living systems; Management; Robots (social); Swarm intelligence**

3455

SYSTEMS (Design)

→ **DESIGN (Systems)**

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SYSTEMS DESIGN (Evolutionary)

→ **Evolutionary Systems Design**

3457

SYSTEMS (Domain of): "The field over which they extent" ¹⁾

J.van GIGCH, who gives this definition classifies as follows the domain of systems:

1. Systems are **living** or **nonliving**
2. Systems are **abstract** or **concrete**

3. Systems are **open** or **closed**

4. Systems exhibit a high or low **order** of **entropy** or **disorder**

5. Systems display organized **simplicity**, **unorganized complexity** or **organized complexity**

6. Systems can be ascribed a **purpose**

7. **Feedback** exists

8. Systems are ordered in **hierarchies**

9. Systems are organized" (1978, p.40)

Item 3 is somewhat ambiguous (see corresponding entries, and "**isolated system**"). Points 5 and 9 could be coordinated.

Since 1978, the systems field has enlarged. We should now add to van GIGCH's list:

10. Systems can be **deterministic**, **markovian** or **chaotic**, i.e. more or less **stable** or **unstable**

11. Systems are natural or artificial (**artefacts**)

12. Systems either adapt, or evolve

13. Systems are **allopoietic** (**artefacts**) or **autopoietic** (**organizationally closed**)

As systemics is still in the making, there may still be more to it!

3458

SYSTEMS DYNAMICS: a CRITIQUE ²⁾

FORRESTER himself made one of the most lapidary critical evaluation of his **method**: "A **computer simulation model** is a theory of the **behavior** it creates" (Quoted by K.B.DE GREENE)

He could have added that it is based on the specific **representation** of the **behavior** of the **concrete system** by the **observer-modelizer**.

Among the difficult and yet unresolved problems for the construction of S.D. models, we can list:

- the possibility of misunderstandings between the "owner of the problem" and the modelizer about the nature of the problem at hand;
- the sometimes doubtful value of the **data** that can be effectively gathered from the concrete **situation**;
- the sometimes dubious **criteria** leading to the introduction or rejection of some **elements** within the **structure** of the **model**;
- the possible neglect of some significant **interactions** between the **elements**, or on the contrary the introduction of spurious ones;
- the impossibility to modelize **simultaneity** of **events** taking place at the same moment in different places in the modeled **concrete system**;
- the necessity to reduce the whole **structure** of the **model** to **binary logics**, adapted to the sequentiality of computers;
- the difficulty to retranslate the obtained results in terms adapted to practical intervention on the **concrete system**.

R.L. FLOOD and M.C. JACKSON made an extended critical survey of S.D. (1991, p.78-83), from four different viewpoints:

"Theory

"a)... Putting in place the **feedback loops** which constitute **system structure** and explain **system behavior** is held to be more important than exact **representation** achieved through precise **reductionist methods**. Obviously this leave S.D. open to charges that it lacks scientific rigour and is imprecise... Of course, from the S.D. point of view, adhering strictly to the scientific **method** would exclude it from addressing most of the problem types for which it was originally intended...

"b) **Soft systems** thinkers question the underlying assumption of S.D. that there is an external world made up of systems the **structure** of which can be grasped using **models** built upon **feedback processes**. To **soft systems** thinkers **social systems** are much more complex than this. They are the creative construction of human beings whose intentions, motivations and actions play a significant part in shaping "system" **behavior**...

"c) It follows that the attempt of S.D. thinkers to model external reality is misguided. **Social systems** are not only too complex for this but the subjective intentions of human beings cannot be captured in such "**objective**" **models**...

"d) Since it is held that social reality is too complex to model, **soft systems** thinkers argue that S.D. **models** must be distorted, one-sided reflections of reality. They are **models** from one, often unstated, point of view. In each **model** there is embedded a taken-for-granted **purpose** which can often be associated with the **transformation** that is being undertaken but ultimately relates back to the particular prejudices of the **modellers**.

Methodology

"a) The **hard systems** critique of SD **methodology** is ... aimed at the **modelling process**... In its concern to be of practical use S.D. is not content to wait upon all the necessary **data** becoming available. It seeks to build its systems **models** based upon judgements about **interdependencies** even when **data** are uncertain or missing...

"b) **Soft systems** thinkers similarly derive their critique of S.D. **methodology** from what they see as the theoretical shortcomings of the approach... **Social systems** are held not to be amenable to quantitative investigation. S.D. attempts to use mathematics in a loose fashion on **variables (rates)** and **states (levels)** that are often far from being clearly identifiable.

Ideology

"a) Rather worrying from the ideological point of view is the manner in which SD analysts act somewhat like elite technicians. They see themselves serving **decision makers**, and managers, as experts providing objective and neutral guidance. There is no involvement of other "**stakeholders**"...

"b) S.D. **modellers** using **feedforward control** appear to believe that there are optimal future **states** that we should steer systems towards. However, these **states** are not made explicit. This is particularly worrying in the case of **social systems** which will contain different **groups** espousing alternative aims and intentions. S.D. **modellers** are likely implicitly to privilege the aims of some **groups** over others"...

Utility

"a) **Hard systems** thinkers believe that S.D. **models** are sometimes based upon poor **data**, sometimes ignore extant theories and often do not undergo a rigorous enough **validation** regime...

"b) **Soft systems** thinkers could forgive S.D. its lack of precision in areas where precision is difficult to obtain – scientific exactitude must sometimes be sacrificed for ready practical usefulness. What they cannot forgive is its attempt to present itself as an objective and neutral approach in the **domain** of **social systems** where "**objectivity**" (at last in the usual sense of that word) and "**neutrality**" are impossible to obtain...

"c) A final point of **soft systems** criticism against S.D. concerns the **relationship** S.D. presupposes as existing between analysts and **decision makers**. The S.D. approach sees these **functions** as separate, the analyst simply presenting expert recommendations to the **decision maker**... According to **soft systems** thinkers... the analyst needs to be much more closely involved with the **decision maker**"

D. MEADOWS et al., recognize that the problem of representing possible abrupt **changes** in a Systems Dynamics **model** is still unsolved: "No existing **global model** has been able to simulate these **changes** successfully, and the **models** that generate **changes** in the **structure** of the **model** do it in a mechanistic way. BARILOCHE **model**, with the **transition** from its "projective" to its "normative" face, is a good example of this" (1982, p.165)

This is of course because **data** used are only quantitative and the **models** themselves practically exclude qualitative **change**, notwithstanding the existence of **feedbacks**, meant to be corrective in order to maintain the system **steady**.

The BARILOCHE model, elaborated in Argentina, had pre-defined **goals**, i.e. was qualitative a priori, once and for all, but altogether **deterministic** and prescriptive.

The abrupt **changes** problem is obviously insoluble in **linear** terms, because **complex systems** are normally **chaotic**. It may remain definitively so, as **chaotic systems forecast** is necessarily probabilistic. The only satisfactory **model** of the system would then be the system itself.

3459

SYSTEMS DYNAMICS (Integrated) ²⁾

This interpretation of Systems Dynamics by E. LASZLO (after P. WEISS) is quite different from J. FORRESTER's **models**.

LASZLO writes: "In fact, the organic **functions** commonly referred to as "**controls**", "**regulations**", "**compensations**", and the like, come under suspicion of being instances of organic systems dynamics rather than **mechanisms** with predesigned and ready pathway **channels**. Under such dynamics the appropriate **response channels** form an *ad hoc* as manifestations of an integrated **response** under some such overall **rule** as "most economical maintenance of an ordered **equilibrium state**" or "attainment of a state of minimum free **energy**" (1974, p.118).

These views seem to relate more to the "why" of systems dynamics than to the "how" and could become a better guide to the construction of **models**, because they correspond to the *basic* nature of well connected systems.

On the other hand, this does not resolve the **modelization** problems of **chaos** in **complex systems**. In fact, most systems dynamics models basically postulate **near-equilibrium stability**, aim at maintaining it and do not have much to say when it is lost.

However, in a recent assessment of S.D., K.DE GREENE writes: "There are a number of important realworld **behaviors** of **complex living systems** that classical systems dynamics cannot completely explain. Systems dynamics should be integrated with **dissipative-structure** theory, **synergetics**, **catastrophe** theory, **field** theory and **chaos** theory in order better to explain and to predict **evolution**, the different kinds of **stability** and **instability**, structural **change** and structural constancy, the different kinds of **equilibrium situations**, **bifurcations**, the **emergence** of collective **behavior** and the qualitative **meaning** of **information**" (1994, p.3).

Consequently, DE GREENE states the following "questions of concern": "Does system dynamics theory as it now stands provide the necessary **fit** to the problems of a world that has become increasingly **turbulent** and unstable since the pioneering foundations were first laid? Can system dynamics be enriched with **constructs** from other systems theories? Can a larger **metatheory**, incorporating systems dynamics, be developed?" (p.5).

FORRESTER himself, in "Urban dynamics" (1969), proposed a number of auxiliary **constructs** that could lead to integrated system dynamics. They have been resumed as follows by DE GREENE (p. 5):

"**Complex systems** have many **levels** and multiple, **nonlinear feedback loops**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

"System **behavior** is counterintuitive, that is, counter to intuition based on experience with simple **feedback** systems; **cause** and **effect** are not closely related in **time** and **space**."

"**Complex systems** are insensitive to **changes** of many **parameters** or constants."

"**Complex systems** resist most policy **changes** (**changes** in how **information** is used to determine **action**) because the system makes compensatory shifts."

"**Complex systems** can be controlled through influence points because the system is sensitive to a few **parameters** and to some **changes** in **structure**; a policy **change** may lead to the radiation of pressures throughout the system."

"**Complex systems** counteract externally imposed corrective **programs** or applied forces; corrective **programs** displace natural internal **processes**."

"**Changes** in a **complex system** can cause **short-term responses** opposite to **long-term responses**; **conflict** between the two can produce a worse-than-before condition; the **short-term** can lead to **long-term** degeneration."

"**Complex (social) systems** tend to **drift** to a condition of low **performance**, because people adjust their **norms** in such a way that degraded **performance** is perceived as improvement so that they then apply more of the original "corrective" **actions**."

A good case-example is the generally applied policy to "improve" urban and suburban motor car traffic: more cars "need" more roads, while more roads are an incentive for more cars, in a repetitive **positive feedback** which would unavoidably lead to global traffic jam in cities if some negative feedback (natural or planned) is not to introduce some **limit**."

DE GREENE concludes that a "larger systemic effort" is needed to incorporate in Systems Dynamics:

"1. The **stochastic-deterministic, continuous/discrete/ discontinuous evolution** of real world systems."

"2. The family of **equilibrium situations** including **nonequilibrium** and **far-from-equilibrium** as well as **equilibrium** per se and restorable, **perturbation-driven disequilibrium**."

"3. The nature of **critical thresholds** and **bifurcation** points."

"4. The **emergence** of **structural instability** and true, qualitatively different **structural change**, as opposed to functional **change** mediated by **change** in the dominance of **feedback loops**."

"5. The qualitative nature of **information** and the evolution toward gain and loss of collective **information**."

"6. The overall properties and **behavior** of **fields** including **order parameters**" (Ibid).

This program would take in account (as a minimum) THOM's **catastrophes**, LIAPOUNOV's condition of **stability**, PRIGOGINE's **thermodynamics of far-from-equilibrium systems** and **dissipative structuration**, LORENZ, SMALE et al. **chaos**, and HAKEN's **synergetics**. This is evidently quite a tall order.

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SYSTEMS DYNAMICS MODEL (Setting up a)²⁾

The following list, established by S. MARTINEZ, shows the main stages in the making of a SD model:

- "1. **Description** of the system. Identification of **elements** and **relationships**."
2. Causal diagram.

3. Precise definition of each magnitude. **Code** of **variables**."

4. FORRESTER diagram or DYNAMO diagram."

5. Equations system."

6. Calibration."

7. **Sensitivity** analysis"

8. Contrasted evaluation of the **model** and use of the **model**: Simulated images and setting." (1993, p.389)

For a detailed description of these stages, see FORRESTER's works. MARTINEZ gives a good summary. R.L. FLOOD and M.C. JACKSON comment extensively on the philosophy, the principles and the **methodology** of S.D. (1991, p.61-86) (See above)

see figure below

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SYSTEMS DYNAMICS (Short history of)¹⁾

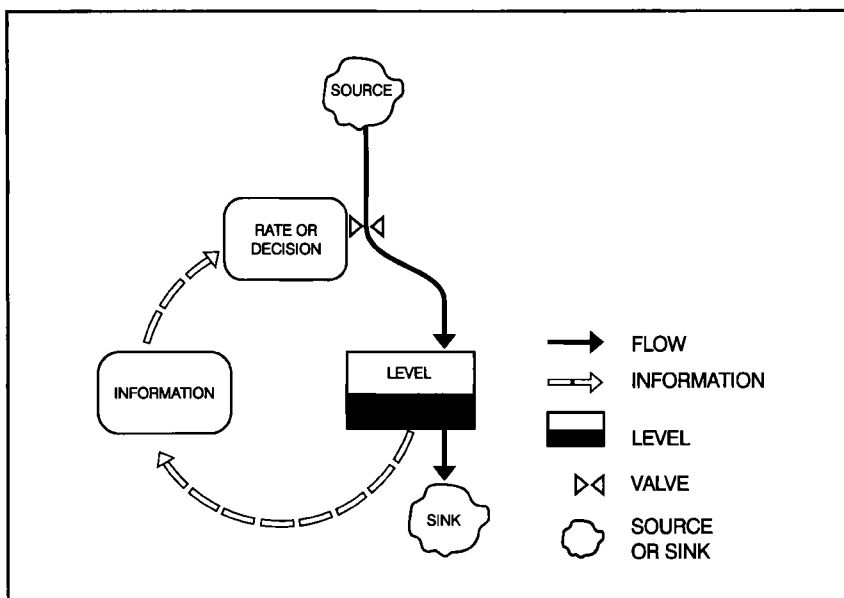
S. MARTINEZ offers the following synthetic sketch of Systems dynamics history: "In the 1950s, J.W. FORRESTER, a systems engineer at MIT..., was commissioned by the U.S. company **Sprague Electric** to study the extreme **oscillations** of their sales and establish a means to correct them. From previous experience, FORRESTER knew that the essence of the problem stemmed from the **oscillations** present in systems that contain inertia **effects** or **delays** and reverse **effects**, or **feedback loops** as basic structural characteristics."

"In 1961, FORRESTER published his report on *Industrial Dynamics* (M.I.T. Press) which marked the beginning of "S.D. technique", based on the study and **simulation** of the **behavior** of **social systems**. In 1968, *World Dynamics* (Wright-Allen Press) was published, which served as the basis for the MEADOWS and MEADOWS Report to the **Rome Club**, a research project that was published under the title *The Limits of Growth* (Potomac Associates, 1972). It could be said that this report and the extensive controversy it provoked, were actually what popularized Systems Dynamics all over the world."

"At present, Systems Dynamics (S.D.) or **Simulation Dynamics** – as it is sometimes called – is a widespread technique in general use for the **modeling** and study of the **behavior** of any type of system that contains **delay** or **feedback** characteristics" (1993, p.384).

It should be added that the cultural background, as well as some methodological assumptions and even the real **goals** of the S.D. based **World models** have been heavily criticized from various sides, specially in South America. (The Argentine FUNDACION BARILOCHE report).

Figure: see entry **SYSTEMS DYNAMICS MODEL (Setting up a)**



Systems Dynamics Model: Basic Structure and Symbols

Adapted from J. DE ROSNAY: 1975, p. 100

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

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SYSTEMS ENGINEERING²⁾

An interdisciplinary concerned with the **interactions** of equipment in larger and larger **complex systems**. (adapted from R.L. ACKOFF, 1972, p.4).

L.von BERTALANFFY gives the following definition, more explicit: "Scientific **planning, design, evaluation** and construction of **man-machine systems**" (1962, p.3).

A more precise definition is given by JENKINS: "The science of designing **complex systems** in their totality to ensure that the **component subsystems** making up the system are designed, fitted together, checked and operated in the most efficient way" (as quoted by M.C. JACKSON, 1992, p.74).

ACKOFF states: "In equipment incorporating automatic **controls**, the **systems approach** is almost inescapable." and "The engineer of course, can no more ignore the human **operator** than the personal psychologist can ignore the machine to be operated".

J. WARFIELD, quoting A.D. HALL III, describes as follows the "Seven phases of Systems Engineering" (in time):

1. **Program planning**... in which those **programs** to be pursued are defined and selected
2. **Project planning**... in which the specific projects to be carried out under a **program** are identified and budgeted
3. **System development**... in which the projects necessary to develop the system are carried out and production plans are made
4. **Production**... in which the systems **elements** and the total system are produced, and plans are completed for its **operation**
5. **Installation**... in which the system is installed and programs are carried out for its **operation**
6. **Operation**... in which the system is in **operation** serving its intended use, and plans are made for its eventual replacement or retirement
7. **Retirement**... in which the system is withdrawn from use, to be replaced by a new system, or is modified significantly" (WARFIELD, 1989, p.169).

The same author also distinguishes "Seven steps of Systems Engineering" in the "Logic dimension":

1. Problem definition
2. **Value system design**
3. Systems **synthesis**
4. **Systems analysis**
5. **Optimization** of each alternative
6. **Decision making**
7. **Planning** for action to implement the next phase" (p.171)

All these phases and steps are fully described in quoted reference.

It would seem, from recent man-made disasters (Chernobyl, the Aral Sea, etc...) that ACKOFF's "**complex system**" should be taken in a still larger sense, incorporating planners, finan-

cists, ecologists and many more so-called **stakeholders** (according to each specific **situation**) into global **participative design**, which would obviously be quite slower, but also more secure...

In effect Systems Engineering is still frequently concerned only or mainly with the **machine part** of the **man-machine system**. Also and particularly both points 7s, about "Retirement or replacement" and "Planning for implementing the next phase" are in most cases forgotten... or even brushed under the carpet.

See: "**Interdisciplinarity**"; "**Multidisciplinarity**" and "**Transdisciplinarity**"

As a result, W. GASPARDI et al. state: "Initially it was expected that systems engineering treated as normative **methodology** of **design** of **complex objects** would become a **paradigm** of the rational **theory of design**. However, those expectations have not been fulfilled. Although systems engineering helped modernize the practical designing **process**, yet it contributed very little to the new **knowledge of design**. Its explanatory capacity proved insufficient to form the **design paradigm**" (1995, p.17).

The crux of the matter seems to be that systems engineering - at least when applied to the **design of man-machine systems**, its main general use - does not include sufficiently the psychological and social factors in these **human activity systems**, described by P. CHECKLAND (1972, p.72).

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SYSTEMS FIELDS TAXONOMY¹⁾

The following taxonomy has been established by R. RODRIGUEZ DELGADO (1992, p.1156), founder and leader of the systems movement in Spain. Some slight modifications and additions have been introduced (marked +).

GENERAL APPROACHES

Theory of knowledge
Cognitive approaches

Systems philosophy

Systems **ontology**

Systems **epistemology**: (**holism** vs. **reductionism**)⁺

Systems **ethics**⁺

General semantics⁺

Axiology

Aesthetics

General Systems Theory

Transdisciplinary approach

Generalization of main scientific principles

In monodisciplinary sciences⁺

In **interdisciplinary** sciences⁺

THEORIES OF GENERAL SYSTEMICS USE²⁾

(all added)

Communication and **information** theories

Cybernetics (1st, 2nd and of 2nd order)

Taxonomy of living systems

Thermodynamics of near and far-from-equilibrium systems

Theory of **catastrophes**

Theory of **deterministic chaos**

Theory of **fractals**

Theory of **games**

Theory of **networks** and **automata**

Theories of **autopoiesis** and **autonomy**

Theories of **artificial intelligence** and **life**

Theory of **hierarchical levels**

Topology⁺

Systems methodologies

General **methods** (metaphors, analogies, linkages, isomorphisms⁺)

Co-participative design⁺

Formal and special **languages**⁺

Operational research

Reconstructability analysis⁺

Systems analysis

Systems dynamics

Specific **models** based on above theories⁺

APPLIED SYSTEMS AREAS⁺

Biological systems⁺

Ecosystems⁺

Economic systems⁺

Familiar therapy⁺

Man-machine systems⁺

Political science⁺

Praxiology

Socio-technical systems⁺

Sociosystems (including animal ones)⁺

Systems education

Systems engineering

Systems management

SYSTEMIC INSTRUMENTS

Simulation models

Electronics

Graphics

Informatics (i.e. computer science), etc...

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SYSTEMS FIELDS THEORY^{1) - 2) - 4)}

System fields theory is proposed by K.DE GREENE for the study of world society within its natural **environment**. He enounces however very general **laws** that makes it a real **systemic** theory, somehow reminiscent of d'ARCY W. THOMPSON's and LAVILLE's ideas about fields.

The **laws** enounced by DE GREENE are as follows:

"First, system fields display different **equilibrium-related behaviors**. Simplest is **equilibrium** and **disequilibrium**, a displacement from **equilibrium** that can be restored by **neg-**

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

active feedback processes... A more complex example is **homeostasis**. Cybernetic theory and **design** can apply to such systems that can exist or function but cannot change **structurally**. Under **far-from-equilibrium** or **non-equilibrium** conditions, **stability** may break down as powerful driving forces attempt to restore the system to **equilibrium**.

"A **second law** is this: Under **nonequilibrium** conditions the system may be especially susceptible to **fluctuations** that under 'normal' conditions would have been **damped**, and to external **fluctuations**. For **far-from-equilibrium** situations, reconfigurational-systems theory replaces cybernetic theory...

"A **third law** states that systems evolving or driven **far- from- equilibrium** may increasingly approach **critical points** or **thresholds**, or **bifurcation** points, beyond which lies **structural change** (e.g., a **phase transition**). Near the **critical point**, the susceptibility to **fluctuations** increases immensely.

"A **fourth law** states that, as a system-field evolves, the **elements** become increasingly **correlated**, eventually encompassing the entire field. In system-fields that are both highly **correlated** and in the **vicinity** of a **critical point**, just one more incremental **change** may engulf the entire field" (1991, p.64).

In such case, as implied by this author, **forecasting** becomes very difficult.

"A **fifth law** states that an evolving system-field may be described as an **order parameter**. An **order parameter** characterizes **micro-macro interrelationships**. **Interactions** at the more **micro-level** generate a field at a more **macro-level**, the **order parameter**, that reciprocally regulates **behavior** at the **micro-level**" (Ibid).

This corresponds obviously to HAKEN's **slaving principle**, in **synergetics**.

"A **sixth law** states that, because of the existence of **attractors** in **phase space**, the future **state** of the system may be unknown, or even unknowable, and that the future **evolution** and **behavior** of the system may be partly or wholly unpredictable" (Ibid).

DE GREENE adds: "From these loosely stated **laws**, various principles, valuable in the **description** and **prediction** of the **evolution** of system fields, can be deduced...

"When the system evolves or is driven **far-from-equilibrium**, then:

"**Principle One**. The system may be hypersensitive to small **fluctuations** that under 'normal' conditions would have been **damped**, and the frequency of related **fluctuations** may increase.

"**Principle Two**. The system may be hypersensitive to external **perturbations** and **fluctuations** (**noise**). And because of critical slowing down, the system may take longer and longer to recover from **perturbations** and **fluctuations**.

"**Principle Three**. **Microlevel changes** may be indicative of incipient **structural change** even though the system appears 'normal' at the **macroscopic level**" (Ibid, p. 64-65).

These **laws** and principles have evidently a great practical value.

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SYSTEMS HEURISTICS (Critical)^{1) - 2) - 3)}

W. ULRICH advocates a "Critical systems heuristics" in order to maintain a continuous reflection on the inevitably partial character of our **understanding** and **design** of **complex human systems**.

ULRICH enounces "Twelve Critically-Heuristic **Categories** of **Pragmatic Mapping**" to be used to obtain a good **representation** of **human systems**, including motivation, **control**, expertise, and legitimation from the different viewpoints of those affected and those involved. (1983, p.244-64).

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SYSTEMS IDENTIFICATION^{1) - 3)}

L. A. ZADEH observed that: "the problem of systems identification is one of the most basic, and paradoxically, least-studied problems in **system theory**" (1991, p.320).

The most complete formal **methodology** for systems identification (and precise description) is G. KLIR's **Reconstructability Analysis**.

In practice, systems are empirically identified by **observers** who state, mostly without much ado: "This is the system" This frequently leads to **underconceptualization** (WARFIELD) and a possibly very incomplete **description** of the **concrete system** considered, leading in turn to unsatisfactory **modeling**. J. WARFIELD's **Interpretive Structural Modeling methodology** is another valuable tool to avoid this kind of problems.

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SYSTEMS INQUIRY^{1) - 3) - 4)}

"The full scope of activities by which we attempt to **construct** systems that are adequate **models** of some aspect of reality" (G. KLIR, 1991, p.77).

KLIR comments: "The **purpose** of systems inquiry is to understand some **phenomenon** of reality, to make adequate **predictions** or retrodictions, to learn how to **control** the **phenomenon** in any desirable way, and to utilize all these capabilities for various ends..."

"We can say that in both systems inquiry and **systems design**, we **construct** systems that are adequate **models** of" something" (Ibid).

There is of course the problem to define what we understand, as **observers**, by "adequate", and as possible actors as "desirable". A long experience demonstrates that opinions and **viewpoints** vary considerably on these aspects (in time as well as in **space**).

For more rigor about the first one, we should expand as much as possible our **knowledge** of the **phenomenon**, **situation** and system, using for instance WARFIELD's **Interpretive Structural Modeling** and/or KLIR's **Reconstructability Analysis**. As to the desirability aspect, we should furthermore "observe the **observers**", in von FOERSTER's terms, or emulate ACKOFF's fables, to better understand our own and others' motivations.

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SYSTEMS (Isomorphic)^{2) - 3)}

Two, or more, **systems models** whose features are equivalent.

Only **models** can be isomorphic. No **model** is totally isomorphic to a **concrete system**. Isomorphic **models** occupy a specific **level** in the whole **taxonomy of abstract systems**.

G. KLIR explains this as follows: "The largest and most fundamental **classes** of systems are those associated with the described **epistemological** types. They are further classified by the various **methodological distinctions**. The more of these **distinctions** are introduced, the smaller **classes** of systems are obtained. The smallest **classes** of systems are reached when systems become totally equivalent in terms of their relations, i.e. isomorphic with each others" (1991, p.222).

This is a **top-down** interpretation.

Another, **bottom-up**, seems possible, in step with increasing degrees of **abstraction**, as shown by KORZYBSKI in his **structural differential**: More and more general **categories** of **objects** can be represented through more and more abstract "**labels**", with a diminishing number or more and more general characteristics. In this sense, for instance, **networks** of different types can be isomorphically characterized, being different however from **hierarchies**, another type of isomorphic **models**.

It would seem that both ways lead to the same general systemic result.

For another angle see: "**SYSTEM (Isomorphic)**".

3469

SYSTEMS (Joined, or coupled Dynamic)²⁾

W.R. ASHBY explains thus the concept: "To join two systems, A and B say, so that A affects B, A must affect B's conditions. In other words, the values of some of B's **parameters** (perhaps one only) must become **functions** of (dependent on) the values of A's **variables**" (1960, p.77).

According to ASHBY: "This **concept** is of the highest importance in biology, in which it occurs frequently and prominently. It occurs whenever we think of one system having an effect on another, or **communicating** with it, or forcing it, or signalling to it" (p.76).

He develops the concept as follows: "In very simple cases, the **behaviour** of the **whole** formed by joining **parts** can be traced step by step by logical or mathematical deduction. Each **part** can be thought of as having its own **phase-space**, filled by a **field**; which **field** it is will depend on the position of the other **part**'s representative point. Each representative point now undergoes a **transition**, guided by its own **field**, whose form depends on the position of the other. So step by step, each goes forward guided by the other and also guiding it." (The **process** has been traced in detail in 1969, Sections 4/7).

"This picture is too complicated for any imaginative grasp of how two actual systems will behave; the details must be worked out by some other **method**. What is important is that the nature of the **process** is conceptually quite free from vagueness or **ambiguity**; so it may properly be included in a rigorous theory of **dynamic systems**" (p.77).

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SYSTEMS KNOWLEDGE¹⁾ - 3)

The body of concepts, **principles**, **laws**, **methods** and **models** that aim at the better **understanding** of complex **concrete** or **abstract wholes**.

As observed by G. KLIR, there is a progressive accretion of such **elements** going on since 1948 (with the first von NEUMANN, WIENER and SHANNON's research) (1991, p.219).

KLIR states that there are two basic ways to obtain systems knowledge:

- "mathematically derived knowledge", with the progressive emergence of formalisms specifically adapted to the study of **complex systems**" (numerous examples in this encyclopedia).
- "experimentally derived systems knowledge... obtained by performing and analyzing experiments with systems simulated on a computer or, possibly, in some other way".

KLIR believes that: "The computer plays undoubtedly the most important role in this respect and it is perfectly proper to view it as the *systems science laboratory*" (p.219-20). This will probably become still truer with **connection machines** and highly **parallel** ones.

However great care should be taken not to "artificialize" real **situations** were human **observers** and actors may introduce **values**, **norms**, motivations, prejudices, etc... practically impossible to translate in **bits** and **bytes**.

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SYSTEMS METHODOLOGIES¹⁾ - 2)

There are various types of systems methodologies, according to their respective aims and uses. (see G. DYER, ISSS, 1992, p.1186). Hereafter a probably quite incomplete listing:

- **Hard Systems Methodology**: "Systems-based methodology, also known as **"systems engineering"**, for tackling real world problems in which an **objective** or an end to be achieved can be taken or given. A system is then engineered to achieve the stated **objective**" (R. RODRIGUEZ ULLOA, Glossary, 1999)

The objective is in general functional, material or organizational in quite precise limits. Human psychological, social and cultural factors are not considered.

- **Soft systems methodology**, applicable to ill-structured problems (P CHECKLAND and his followers, principally in England, including more evolved **Total System Intervention** - M.C. JACKSON, R.L. FLOOD and others)
- **Global Design and Interactive Management**, based on **Interpretive Structural Modeling** and assorted practical **networking methods** (J. WARFIELD and followers in U.S, Mexico and various developing countries)
- **Architecture of Complexity**, applied to the study of the internal **structures** of **complex systems**, in order to manage them rationally (H. SIMON)
- **Reconstructability Analysis and General Systems Problem Solver**, aimed at creating more adequate **models** of **complex systems** and ways to manage them (G. KLIR)
- **Coparticipative Design**, aiming at a better integration of human groups in their own **design** projects (B. BANATHY and the FUSCHL Group)
- **Management Science**, developed principally along **metadisciplinary concepts** and corresponding practical **methods** (R.L. ACKOFF and his Pennsylvania University team)
- **Systems Dynamics**, developed in order to simulate **complex systems** on computers (with sometimes doubtful results) (J. FORRESTER and his M.I.T. team)
- **The Viable System** modeling, aimed at defining the basic **parameters** of **complex systems** in order to modelize them and evaluate their **viability** or the **changes** to be introduced (S. BEER)
- **Expert systems**, based on human experts **knowledge** transferred to computers and applicable to specific **situations**

In some cases **Systems Analysis** and **Systems Engineering** techniques are used within these larger **reference frames**.

3472

SYSTEMS MOVEMENT¹⁾

"A loose association on worldwide scale of people from different disciplines of science, engineering, philosophy, and other areas, who share a common interest in ideas (concepts, principles, **methods**, etc...) that are applicable

to all systems and that, consequently, transcend the **boundaries** of traditional disciplines" (G. KLIR, 1991, p.19).

KLIR offers a synthetic history of the systems movement in this reference (1991, p.19-39 and p.346-7). P.B. CHECKLAND also develop an interesting evaluation in the same collective work (p.259-68).

The systems movement however, after 40 years, find itself in a serious predicament.

The following harsh critical **evaluation** of the systems movement by D. H. Mc NEIL is well worth of attention.

"The modern history of the "systems movement" began with the complicated organizational demands during World War II. In subsequent decades, very large governmental, corporate, aerospace, and computer **operations** engendered systemic developments. One might expect the theoretical foundations of **"systems thinking"** to have progressed apace, but such has not been the case. If anything, there is less **relevance** and less credibility in the systems professions today than at any time since von BERTALANFFY set forth the **goal** of a **"General Systems Theory"**. University curricula in systems are now being dismantled or merged with other subjects. Professional societies concerned with the subject matter of systems are weak and philosophically adrift.

"The "systems movement" has failed and its offshoots in the "environmental movement" will fail also unless some changes are made. After nearly half a century of fitful efforts, there is no comprehensive theory of systems, no standard textbook of fundamentals and no definitive workbook of techniques and applications. Attempts to produce politically correct systems studies within the conventional Science of engineering curricula have only served further to emasculate the contribution that systemological discourse would make on its own merits.

"The "systems movement" has been its own worst enemy. It has utterly failed to define itself and its subject matter and has not established itself as a discipline. On the one hand, this invites charlatans to preempt its concepts and misrepresent them. On the other hand, it prompts its professionals to seek respectability within the purview of conventional sciences...

"There will be a great deal of consolidation and clarification to do" (1992, p.1077-8)

Unfortunately, there is much truth in Mc NEIL'S indictment, even if it will probably forever be difficult - and inappropriate - to transform **systems thinking** or **systems approach** into a "discipline". This would put it nicely in a small and segregated intellectual **niche**, while it really should become the basic ground for *anybody confronted with complex situations of any kind, anywhere at any time, i.e., all of us!* This systems literacy general need is for sure a very difficult problem of educative **design** (F. CROWELL, 1992, p.964-975).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This encyclopedia tries to offer general **information** on systems views and to promote **semantic** clarification. It may possibly also be helpful to convey a clearer view of the "agglutinating" and connective global character of **systemics**, in the hope that this could lead to a better general and ordered formulation of "**systems thinking**".

However, much more fundamental material should be produced, and practical ways to perfect them and transmit them should be invented.

It should also be noted that very interesting and useful synthetic work has been done outside the anglo-saxon world, specially in France (J.L. LE MOIGNE, E. MORIN) and in Germany (G. KLAUS). Good systemists should cultivate a worldly connected perspective!

... And should urgently put it to practical uses.

3473

SYSTEMS PATHOLOGY

→ Pathology of complex systems

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SYSTEMS PHILOSOPHY^{1) - 3)}

W. ULRICH (1983, p.321-3) has imagined a hypothetical debate between H.A. SIMON and C.W. CHURCHMAN, two outstanding systemists whose views are at odds on a number of points. ULRICH extracted the **elements** of this fictitious debate from SIMON's "Science of the Artificial" and from CHURCHMAN's "The Artificiality of Science". Hereafter, a short summary of this debate (on which thesis ULRICH obtained both supposed contenders' agreement):

For more precise information see reference.

see table below

Table: see entry **SYSTEMS PHILOSOPHY**

Position	H.A. SIMON	C.W. CHURCHMAN
Subjectivity is	avoided	not avoided
Complexity is	hierarchical	not hierarchical
Wholeness of systems (holism) is	denied except in a pragmatic sense	critically considered
Reducing complexity of systems to "simple" subsystems is	a source of knowledge	a source of irrelevance
The purposeful character of systems (teleology) is	denied (teleological fallacy)	critically considered
The decomposability principle is	accepted	rejected
The description of systems must	focus on redundancy	focus on uniqueness
The crucial design task to be solved is	problem decomposition	problem identification
The designer's main tool is	objectivity	subjectivity

In a more taxonomic way, R. RODRIGUEZ DELGADO describes as follows the different possible meanings of so-called systems philosophy:

"a) A global attempt to understand the Universe and the existence of Man

"b) A partial generalization of **knowledge**, like Philosophy of History, Philosophy of Science, Philosophy of Art, etc.

c) An **Ontology** or Theory of the abstract Being

d) An **Epistemology** or Theory of Science

e) An instrument for reaching a synthesis of scientific **knowledge**

f) A way of orienting human **action** in an intelligent way

g) An instrument for the positive transformation of Man and Society" (1993a, p.20).

This author sees in systems philosophy a trend toward the integration of different or even opposed philosophical systems, as elaborated for example by Nicholas of CUSA, THEILHARD de CHARDIN, J. ORTEGA Y GASSET, Karl MARX and E. LASZLO.

Conversely, R. RODRIGUEZ ULLOA speaks of a "**Weltanschauung**", wherein a philosophy is merely implicit.

3475

SYSTEMS REPRESENTATION²⁾

Any way to construct a **model** of a system.

Really **complex systems** can practically be represented only at the price of gross simplification in some coarse **homomorphic** form, using for example an **aggregation mode**. A good example are the **models** used in **Systems Dynamics**.

This is not to disparage such **models**, which are the best available for practical **purposes**, but only to take a clear view of their limitations.

Only what M. BUNGE calls systems with a "denumerable composition" as "a molecule or an industrial plant" (1979, p.16-7) can be adequately represented by a **graph** or its equivalent **matrix**, or the corresponding set of equations.

BUNGE acknowledges that: "Obviously neither the **graph** nor the **matrix** representation of a system suffices for all **purposes**. It represents only the composition, **structure** and **environment** of a system with neglect of its **dynamics**. A more complete representation can only be obtained by setting up a full fledged dynamical theory incorporating and expanding the **information** contained in the **graph** or the **matrix** representation... namely the **state space representation** (p.19-20).

Even this supposes hypotheses about the system, derived from a more general **frame of reference**.

3476

SYSTEMS RESEARCH^{1) - 2) - 3)}

"The totality of scientific and technological problems (research and development) which, in spite of their variety and specificity, have one substantial feature in common

According to BLAUBERG et al.: "the main tasks of the logic and **methodology** of systems research may be listed as follows:

- the construction of **conceptual means** - systems of concepts, conceptual **models** of a special type, etc... - for the expression (**representation**) of the **systems nature** of corresponding **objects**.
- the evolvement of **apparatus** for the **description** of the most important characteristics of systems **objects** - **connections** (including their typology), systems of **connections**, **interrelations** of system and **environment**, the **hierarchical structure** of systems, problems of **control**, etc..
- the construction of **formalized systems** for the **description** of systems **objects**, including the formulation of specific **rules of inference** for such systems" (Ibid, p.88).

3477

SYSTEMS SCIENCE^{1) - 3)}

"That field of scientific inquiry whose objects of study are systems" (G. KLIR, 1993, p.27).

The word "science" has evoked a serious resistance among "hard" scientists, because of the very general and abstract meaning of "system", the supposed **object of inquiry**.

Still less adequate seems to be the expression "systems ScienceS" (as it appears now in the official name of the "**International Society for the Systems Sciences**"), evoking a more or less unorganized ragbag of scattered disci-

plines, and encouraging systemists to seek "a politically correct shelter for their work under the umbrella of orthodox science" (D. Mc NEIL, 1993b).

This has been sensed by quite a number of "system scientists", as for instance L. TRONCALE, who considers this expression as merely "a collective non-specific term... and a questionable use of the term "science" similar to that found in "social science" (1984, p.45).

KLIR himself adds: "Unfortunately, this definition, which appears reasonable on the surface, only begs the question. To make it operational, and thus useful, we have to establish some broad and generally acceptable characteristics of the concept of a system." (Ibid). The whole of this KLIR's paper on the subject is dedicated to a "guided tour" of this difficult task and can be used as an introduction to the subject.

Some interesting statements by KLIR:

"Classical science, which is predominantly oriented to thinghood properties, and systems science, which is predominantly oriented to systemhood properties, are two distinct perspectives from which scientific inquiry can be approached. These perspectives are complementary. Although classical scientific inquiries are almost never devoid of issues involving systemhood properties, these issues are not of primary interest to classical science and have been handled in an opportunistic, ad hoc fashion.... While the systems perspective was not essential when science dealt with simple systems, its significance increases with growing **complexity** of systems of our current interest" (p.28-29).

On the role of the computer in relation to "systems science", KLIR states: "The computer has, in fact, a dual role in systems science. In one of the roles, it is a methodological tool for dealing with systems problems. In the other role, it serves as a laboratory for experimenting with systems" (p.38).

(This last aspect is now becoming very significant in the field of **artificial life**).

KLIR also states that the study of "systemhood" starts with the development of "... a comprehensive conceptual **framework** by which the whole spectrum of conceivable systems is divided into significant **categories**. The second step is to study the individual **categories** of systems and their **relationships**, and to organize the **categories** in a coherent **whole**. The third step is to study systems problems that emerge from the underlying **set** of organized systems **categories**. Finally, we address methodological issues regarding the various types of systems problems" (p.38).

"**Simplification methods** are crucial for dealing with **phenomena** of organized **complexity**. Since organized **complexity** is the prime territory of systems science, these **methods** play a key role..." (p.47).

F. HEYLIGHEN states: "Systems science (including cybernetics) is not a traditional discipline concerned with the study of a particular **domain**, but a meta-discipline, concerned with the **domain-independent** modelling of general systems. (van GIGCH). As such, it does not aim to find the one true **representation** for a given type of systems (e.g., physical, chemical or biological systems) but to formulate general principles about how different **representations** of different systems can be constructed so as to be effective in **problem solving**" (1990a, p.423).

Should there be *systems scientists*? G. KLIR so believes: "The role of developing and applying the systemhood expertise must be undertaken by a scientist of a different kind, a *systems scientist*, whose specialization is this very expertise" (1991, p.23). This seems at the same time correct and doubtful. It is correct because we undoubtedly need people able to understand, explain and, in many cases, manage **complex systems**. A systemic formation should be a very general feature of **knowledge** acquisition. This explains however why the idea could be questioned: If systems science becomes an academic specialty, it could promptly be relegated in some more or less secluded academic cloister and become lost for the millions who really need it.

Systems science is a meta- or trans-discipline (or, possibly better, a **meta-methodology**) for everybody and should not be simply reduced to a discipline status, even when and where it must be taught. In KLIR's words: "Systems science has also its own **methodologies**, which I view as a coherent collection of **methods** for dealing with those types of systems problems that emanate from a particular conceptual **framework**. Furthermore, systems science has its own **metamethodology**. Its purpose is to determine characteristics of individual **methods** (such as computational **complexity**, **performance**, and range of applicability) and utilize these characteristics for selecting the right **method** for a given problem in a specific **context**."

"In spite of all its science-like characteristics, I argue... that systems science is not a science in the ordinary sense, but rather a *new dimension in science*" (1991, p.352).

This has much to see with the future of Systems Science, another subject widely tackled by KLIR (1991, p.185-90). On one hand, concepts, **principles**, **methods** and **models** – i.e. the scientific aspects – should be constantly extended in order to increase **complexity understanding** for practical and theoretical uses. On the other hand, a general **strategy** and **tactics** should be devised to bring **systems knowledge** to those who could benefit from it – i.e. the sociological and ethical aspects, in terms of the systemists responsibility.

According to G. ANDERSEN: "Systems science can be considered as a human evolutionary system with emergent properties – the **structure** of the **components** changes over time and new **information** is created out of this **process**" (1995, pers. com.).

3478

SYSTEMS SOCIETIES¹⁾

A considerable number of Societies interested in systems have appeared worldwide. However, most of them are merely concerned with some special aspects of systems, as for example: Artificial Intelligence, Computer Science, Fuzzy Logic, Operation Research, Systems Dynamics, Systems Engineering, Systems Simulation, etc...

If Systemics and Cybernetics are to be considered as the hard core of which more specialized disciplines are kinds of conceptual satellites, the following list of Societies seems to cover the field in a quite exhaustive way:

- American Society for Cybernetics
- Argentine Society for Systemics and Cybernetics
- Austrian Society for Cybernetic Studies
- Centre for Systems Studies (University of Hull)
- Collège de Systématique de l' AFCET (Paris)
- European Systems Science Union
- Hellenic Systems Society
- Instituto Andino de Sistemas (Peru)
- International Association of Cybernetics (Belgium) (Dissolved in 1999)
- International Federation for Systems Research (Linz)
- International Society for the Systems Science
- International Systems Institute (Carmel, CA)
- Italian Association for Research on Systems (Milano)
- Polish Systems Society (Wroclaw)
- Slovenian Systems Society (Maribor, Slovenia)
- Spanish Society for General Systems (Valencia, Spain)
- Swiss System Society (Neuchâtel)
- Systeem Groep Nederland (Amsterdam)
- United Kingdom Systems Society (Hull)
- World Organization of Cybernetics and Systems (Paris)

Most of these Societies are active organizations, which organize events, have research groups, and publish books, booklets and in some cases, a Newsletter or a Journal. For details, see, in most cases, specific heading.

There are some other Societies, whose existence seems merely nominal, as well as a number of informal groups in different countries, some of which will probably become officially Systems Societies.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3479

SYSTEMS TEACHING¹⁾

A number of universities have launched programs for systems teaching. Unfortunately, most of them were partial and generally dominated by some more specific systems applications as **systems analysis**, **systems dynamics**, **systems engineering**, or conceived merely as a kind of vague humanistic cultural complement.

In the first case they were frequently considered by specialists as useless, and even a hindrance in technical applications because of their "fuzzy" character. In the second case, they were merely viewed as an ornament without real content. In all cases, they were evaluated as not leading to any specific professional activity (which is of course not the point, even if the "job" is the main concern of nearly all students). As a result, they were generally shunted of downright suppressed.

One of the best recent attempt to introduce a "Master of **Systems science**" degree has been at the **operational research** school of University of Valencia, Spain. (L. FERRER FIGUERAS, 1992, p.1168-74).

One wonders:

- if systems teaching should not be first based on the study of practical **situations** (generally **messes**!) in a great variety of fields;
- if it should not be introduced already at high school and introductory college **level**, not as a specific subject matter, but as a **methodology** perfusing *all* subject matters;
- if the same **methodology** should not be promoted at universities, for example in extra-curricular discussions; and inter-departmental research programs on **complex situations**.

3480

SYSTEMS (Technical Macro-)

→ **Technical Macro-Systems**

3481

SYSTEMS TECHNOLOGY¹⁾

The open **set** of **models** (**functional**, **structural**, **hierarchical**, **catastrophic**, **chaotic**, **dissipative**, **thermodynamical**, etc...) which are available for **systems research**.

This is "quantitative systems science" and "Under the various headings of **systems engineering**, **management science**, **operation research**, computer science, etc., systems **concepts** are translated into operational terms" (E. LASZLO, 1972, p.9)

3482

SYSTEMS: the THERMODYNAMICAL viewpoint¹⁾

From the thermodynamics viewpoint, systems may be differentiated within three basic **categories**, which E. SCHWARZ describes as the follows:

"Non-conservative systems are called dissipative, since part of their energy dissipates as heat" (1990, p.100).

It should be observed that all **concrete systems** are non-conservative. Furthermore the "equilibrated" systems of whom the author speaks in the next paragraph as having attained "the state of maximum **disorder**", are devoid of **structures** and incapable of carrying out any **function**.

SCHWARZ pursues: "The **closed systems**, isolated from the **environment** find themselves either equilibrated (characterized by a maximum **entropy**, i.e. in a **state** of maximum **disorder**), or near the **equilibrium**, in this case they tend towards the **equilibrium state** (maximum **entropy**)" (Ibid).

The so-called "**isolated system**" is a mere **abstraction** (See the discussion of the terms "isolated", "closed", "open") which serves to explain the **2d. Principle of thermodynamics**. An imperfect **model** of such a system can be obtained by enclosing a gas in a tight container. Such a "system" is however unable to develop any organized **activity**.

Next E. SCHWARZ describes "the **dissipative-open systems**... near the **equilibrium**... described by a quite precise equation, which permits to compute the **stationary state** towards which they tend" (Ibid). See "**Systems near equilibrium**".

Finally: "The **dissipative-open systems far away from equilibrium** are described by differential equations where the relation between the general forces and the **flows** is not anymore **linear**" (Ibid. p.101).

These systems may evolve "toward a (more) organized **state**, with decrease of internal **entropy** (by importing **negentropy** from their **environment**)" (Ibid, p.102).

This last statement is debatable at least in its formulation. Highly organized systems have a higher **rate** of **entropy production**, which is the price they have to pay for their superior degree of **organization**. However they maintain this by discharging in their **environment** considerable quantities of degraded **energy**.

3483

SYSTEMS THEORY^{1) - 2) - 3)}

"The generalization of explanations from several analytical studies in order to understand a complex **phenomenon** or **process** within a discipline" (1985., p.45).

L. TRONCALE sustains his definition explaining that systems theory "often leads to a **model** of the **process** with the purpose of achieving a subjective, qualitative **understanding** of the **phenomenon** that goes beyond the quantitative **knowledge** obtained from the specific cases... (and) emphasizes broader comparisons than **systems analysis** across different specific systems within a discipline or **phenomenon**; (it) uses some **isomorphies**, but many fewer than the full **set**; overall, systems theory is one step more abstracted than **systems analysis** in its use of mathematics".

The qualitative aspect in systems theory are indeed dominant, while quite more than subjective. Systems theory also evades of the **limits** of disciplines.

It however does not seem obvious that systems theory uses more mathematics and in a more abstract way than **systems analysis**, nor that this should be its unavoidable **goal** or necessity.

More generally, it seems that systems theory, if such an embracing thing already really exists, is taking shape through a slow interconnection and **interaction** of an array of concepts and **models** coming from very diverse disciplines.

Numerous examples could be given. Here are some:

- **dissipative structuration**: a concept coming from chemistry and **thermodynamics**, but useful in social **ethology** and in social sciences.
- **deterministic chaos**: a concept that originated in celestial mechanics, astronomy and meteorology, but now allows for the interpretation of numerous **phenomena** in multiple disciplines.
- **feedback**: a practically universal **model** of **regulated** or **controlled processes** in any **class** of **complex living** entities and mechanical devices.
- **autopoiesis**: a nearly universal **model** of the way complex entities constantly reconstruct themselves and secure their **autonomy** and **survival**.
- **networks**: a more and more generalized **model** of interactive **behavior** between **elements** leading to global **coherence**.

(For a more complete list see numerous entries in this work).

It should however be strongly emphasized that systems theory is not merely an unorganized collection of more or less systemic theories coming from specialized disciplines. Such theories (as for instance, **control** theory) can usefully contribute to systems theory as a whole, but only if properly integrated in a global **transdisciplinary** perspective, i.e. correctly interconnected with each others.

This is even true of various very promising general theories recognized as typically systemic: HAKEN's **Synergetics**, SABELLI's **Process theory**, MILLER's **Living systems**, Mc NEIL's **Systemology**, LE MOIGNE's *Théorie du Système Général*, for instance.

Possibly, systems theory still lies in the future, if it becomes one day possible to establish a genuine integrating **metatheory in systems research** from the still presently growing **set** of generalising concepts and **models**.

Such a systems theory could instate a new **level** of metascience.

3484

SYSTEMS THEORY ("Hard" or "Soft")^{1) - 3)}

"Hard" Systems Theory

J.van GIGCH describes the nature of so-called "Hard" Systems Theory, as "the continuation of the influence of sciences such as physics and mathematics".

"Hard" Systems Theory and the sciences from which it derives demand rigor and strict quantification. They rely on the deductive **paradigm** and on exact **rules** of procedure and proof... Hard Systems Theory usually provides good descriptive **models** of the **universe** but poor normative ones" (1978, p.73).

"Soft" Systems Theory

According to van GIGCH, "Soft" Systems Theory "views a system as a portion of the world that is perceived as a unit and that is able to maintain its **identity** in spite of **changes** going on in it" (from A. RAPOPORT, in "G.S. Yearbook, Vol 15, 1970, p.15-25).

"Soft systems ... may adopt several **states** due to **environmental** conditions yet preserve their original **identities** in spite of these influences. The solar system, a fountain, a family, a beehive, a city, a nation, and a business firm are systems that undergo continuous **changes** in their **component elements** and probably in their outward perceived shape. Systems defined as soft systems have **structure**, react to the **environment** by changing their **short-term functions**, undergo slow **long-term changes**, but maintain **identity** and evolve" (p.74).

"Soft" Systems Theory faced a strong resistance from many "Hard" Systems scientists, disorientated by what seems to them a lack of methodological rigor.

The well-known following quip by H.von FOERSTER still remains significant: "Hard" sciences are hard because they study soft problems, and "Soft" sciences are soft because they study hard problems".

3485

SYSTEMS THEORY: Historical roots¹⁾

In his "Roots and branches" paper (2002, p. 417-428), K. BAUSCH explores the conceptual roots of **systems thinking**

He distinguishes:

- the 17th C. mechanical **model** (DESCARTES, - NEWTON, LEIBNIZ)
- the 19th C. organic model (SPENCER, MILLER, SUMNER)
- the early 20th C. **equilibrium** model (PARETO, PARSONS)
- the early 20th C. **homeostatic** model (CANON)
- the early and mid 20th C. **process** model (SIMMEL, MEAD, ALLPORT)

He also describes what he calls "new branches" i.e. the wide **variety** of more recent models that introduced significant new **approaches** in **systems theory**. Among many others he cites:

- HAKEN (**Synergetics**)
- PRIGOGINE (**Dissipative structuration**)
- EIGEN (Encapsulated **hypercycle**)
- CSANYI (**Emergence** of systems)
- KAUFFMAN (**Self- organization**)
- HABERMAS (Communication **action**)
- MATURANA and VARELA (**Autopoiesis**)
- WARFIELD (**Generic design**)
- FLOOD and JACKSON (**Critical systems thinking**)
- BICKERTON (**Language and representation**)
- LUHMANN (Systemic **process**)
- BANATHY and CHRISTAKIS (**Social systems design**)
- CHECKLAND (**Soft systems methodology**)
- GLEICK (**Chaos**) (in fact introduced by E. LORENZ)

Other angles have also been explored by Deborah HAMMOND (2002, p. 429-440) and Ch. FRANÇOIS (1999, 2000)

These various essays could become useful **inputs** for a more integrated and complete history of Systems thinking, still to be written

3486

SYSTEMS THEORY (Liberating)¹⁾

R.L. FLOOD in his work published under this title (1990), argues that Systems theory must be "liberating", i.e. reveal lost or suppressed **knowledges** in general, and even in Systems theory itself. This is related to the **dominance** of restrictive scientific and cultural **paradigms**, many times manifested through power relations and ideological biases.

The problem is obviously to avoid replacing some types of biases and power politics (not only present in politics) by others. Systems theory should be carefully watched over by systemists and non-systemists in order to avoid such risks. We would have to undertake a serious inquiry about the systemic **significance** of **coercion**, power abuse and ideologies.

See: "**Societal order parameters**".

3487

SYSTEMS THINKING (Critical)^{1) - 2)}

M.C. JACKSON, who introduces this concept, describes as follows the "five pillars" on which it is built:

- **Critical awareness**, which "... concerns **understanding** the strengths and weaknesses and the theoretical underpinnings of available **systems methods**, techniques and **methodologies**. Critical systems thinking is relentless in its pursuit of appropriate means of interrogation and in using these on the various **systems approaches**... Another form of critical awareness comes from closely examining the assumptions and **values** entering into actually existing **systems designs** or any proposals for a **systems design**"...
- **Social awareness** which "... should make users of **systems methodologies** contemplate the consequences of the use of the employed approach... Social awareness also involve recognizing that there are certain organizational and societal pressures which lead to certain **systems theories** and **methodologies** being popular for guiding interventions at particular times".
- **Complementarism at the methodological level**: "This requires a **methodology** (or perhaps a **meta-methodology**) which respects all of the other features of critical systems thinking" (FLOOD and JACKSON attempt to create such a **meta-methodology**, called "**Total System Intervention**" - 1991a).
- **Complementarism at the theoretical level**: "This requires an equal commitment to the complementary and informed development of all varieties of **systems approach**..."

Further, the claim of any one theoretical rationality, whether **functionalist**, **structuralist**, interpretive or emancipatory, to absorb all others, should be resisted"

- **Human emancipation**, seeking "... to achieve for all individuals the maximum **development** of their potential" (JACKSON, 1993, p.124-5)

These views, while somewhat ideologically tainted, are certainly important in order to avoid... ideological distortions in name of **systems thinking**.

For a quite complete **description** of Critical Systems Thinking see Chapter 7 in M.C. JACKSON (1992, p.183-212)

3488

SYSTEMS THINKING: Some critical appraisals¹⁾²⁾³⁾

In his well known essay on "The Rise of Systems Theory" (1978), R. LILIENFELD was very skeptical about the practical use of **systems theory**. He wrote: "No evidence that systems

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

theory has been used to achieve the **solution** of any substantive problem in any field whatsoever has appeared" (p. 192)

LILIENFELD critique was directed obviously at those scientists and technicians who thought that systems theory offered a cheap short cut for the solution of specific problems in specialized trades: a kind of **magic bullet** to avoid slow and painstaking research in the traditional way

He did however miss the real point, which is that systems's **concepts** and **models** offer the base for

1- a **transdisciplinary language** that fosters the capacity of reciprocal understanding between specialists

2- a needed complement for an integrated view of **complex systems**, as they exist and maintain themselves in their **environment**

F. CAPRA gives the following examples related to this second aspect: "It could be argued even then that the understanding of living **organisms** as energetically open but organizationally closed systems, the recognition of **feedbacks** as the essential **mechanisms** of **homeostasis**, and the cybernetic **models** of neural **processes**- to name just three examples that were well established at the time- represented major advances in the scientific understanding of life" (1997, p. 78)

In fact, traditional research in specialized area are complemented by systemic thinking

The necessarily **reductionist** research in specific **processes** (as for ex. the workings of enzymes) are in no way contradictory to a global view of the **living system**

The **part** becomes integrated in the **whole**, but must still be also researched as a part in itself

3489

SYSTEMS TYPES ¹⁾

J. SUTHERLAND distinguishes the following types of systems:

"1) **Deterministic**: No significant relational or structural **changes** through **time**. **State** alterations are negligible.

"2) **Moderately stochastic**: Some significant **changes** in coefficient and **parameter** values, but invariant basic structural and relational properties.

"3) **Severely stochastic**: Significant relational and some structural (i.e. **state-variable**) changes through **time**, where relational **changes** are reasonably well contained and where structural **changes** are **periodic** (replicative) or are drawn from a limited population of **state-variables** (determinant **array**).

"4) **Indeterminate**: Significant structural **change** through **time**, such that the **state-variables** or major determinants cannot be preassigned except partially and probabilistically;

both causal and structural properties either empirically inaccessible or unallegorizable; **state-changes** independent of prior **states**" (1973, p.146).

We should now (1992) add the **chaotic** type, which covers partially the three last types proposed by SUTHERLAND and introduces an apparently "**stochastic determinism**".

Another basic array of systems types, are, in the words of G. BROEKSTRA: "... the three **levels** of inquiry and description as distinguished by PRIGOGINE in physics: reversible classical or Newtonian **mechanical systems**, **irreversible equilibrium systems** or systems near **equilibrium** as dealt with by **classical thermodynamics**, and **nonequilibrium systems** of the kind called "coherent, evolving systems" or **dissipative structures**" (1993, p.74).

E. JANTSCH (1975, p.69 hereafter) and later on B. BANATHY (1988), in a somewhat modified form, offered the following classification of **human systems**:

"Rigidly **controlled systems** pursue prescribed operational targets in prescribed ways for attaining them (Examples: factories, bureaucracies)

"**Deterministic systems** pursue prescribed operational targets but select between various ways and **inputs** for attaining them (Examples: vertically organized production lines in industry, bringing into play various **sets** of material and nonmaterial **resources** and in various sequences)

"**Purposive systems** pursue prescribed strategic **goals** or multigoal **patterns**, but select the corresponding operational targets (and the ways for attaining the latter) (Examples: Industry developing various and possible innovative product lines, or diversifying in products and services under **function-oriented** headings such as power generation, transmission, distribution and utilization, or food production, processing and distribution)

"**Heuristic systems** select their **goals** or multigoal **patterns** flexibly within the **framework** of a prescribed overall **policy** (Examples: Industry developing new functional foci such as **environment**, or education; universities setting up **interdisciplinary** programs)

"**Purposeful systems** formulate and select **policies** in the light of the long-range outcomes (system **states**) of their own and their **environment's** potential **dynamics**. (Examples: New institutional **roles** for business, e.g. planner for society, or for higher education, e.g., education for self-renewal; **ecosystemic** view of world **dynamics** and **policies** geared to **stability** rather than **growth**, etc.)

JANTSCH states: "The above classification is of general validity and may be applied to **human systems** of all **sizes** and **scopes**. (Ibid) → "**Systems (Basic classes of)**".

T

3490

TAKE-OVER LAW ^{1) - 4)}

The superseding of an **evolutionary cycle** by another one.

This notion is introduced by D. DUBOIS and is related to the replacement of older vegetal and animal groups by new ones, with more complex features in their biological **organization** (1990, p.134).

This is also the case for man as a species and, possibly, is now becoming a characteristic of successive **levels** of **complexity** in **socio-systems**.

3491

TAMPERING ¹⁾

An inconvenient way to interfere with the basic **parameters** which govern "both the transient and **asymptotic behaviors** in an **autonomous system**" (Adapted from G. KLIR, 1993, p. 21).

KLIR states: "It is absolutely essential... that the **time-dependent inputs**, or forcings, do not change **autonomous dynamics** in any way" (p.21).

Tampering is frequently a result of an insufficient **knowledge** or **understanding** of **initial conditions** and **environmental constraints** rigging the system.

3492

TASK ALLOCATION ^{1) - 4)}

"The global **process** by which a **group, organization** or **society** assesses its current needs and "assigns" a certain number of members to perform specific tasks" (Adapted from D.M. GORDON, 1995, p.50).

D.M. GORDON found that, in insect societies, task allocation is a "**distributed process**", each individual being able to "perform any of a number of tasks", according to local and temporal circumstances. This seems to result from an **interactive perception** of global **environmental situations**. The introduction by GORDON of external **disturbances** in an ant nest increased or decreased the number of individuals performing some specific tasks, as for instance nest maintenance or foraging (Ibid).

More or less automatic task allocation seems also to be at work in human **groups**:

1) at a global **level**, regulating the number of individuals in each trade, compensating - with some **time lag** - for excess or lack of some kinds of professionals.

2) at a local **level**, for example increasing the presence and **activity** of some types of individuals in case of a disaster.

Task allocation is possibly a generic property of active **networks**, related to reciprocal sensing between **elements** and global fluctuating **stability** (as in ASHBY's **homeostat**, or through the action of **synaptic weights**).

3493

TAUTOLOGY ³⁾

A redundant proposition or "A proposition which repeats the same idea in other terms" (E. SCHWARZ, 1993, P.13)

→ **Structural differential**

This is the classical philosophical **meaning** of the word. In SCHWARZ's words: "According to **context**, a tautology can be no more than a repetition or triviality that does not add anything to which is known... or on the contrary a **self-referential** proposition"

Indeed, the general **concept** of **autopoiesis** introduces an interesting new shade of **meaning**, related to the **self-reproduction** or **organizational closure** of **autopoietic systems**.

E. SCHWARZ describes it in this case as "... a foundational **self-referential** proposition, which is fundamental or basic, as for example the **identity** principle in classical **logic**: $A=A$, what is, is" (1993, p.13)

But... is this meaningful, or meaningless?

3494

TAXON MEMORY ³⁾⁵⁾

Data storage in the **brain** through ordered listing of related items.

R. NUMELLA CAINE and M. CAINE explain: "These memories consist of items that do not depend on a specific physical **context**. They include prototypes or **categories** that represent a generic item, such as bird or house or dog; the **contents** of **categories**, such as types of trees or cars; and **routines** and **procedures**, such as driving" (1994, p. 42)

The basic features of taxon memory are:

"1. **Information** in taxon memories are placed there through practice and rehearsal...

"2. Taxon **learning** is linked to extrinsic **motivation** and is powerfully motivated by external reward and punishment...

This is evident when students memorize for tests instead of seeking to understand ideas...

"3. Our taxon memories are physiologically "set" in a way that makes them quite resistant to **change**, as anyone who has tried to change a **habit** knows...

"4. Items in our taxon systems are relatively isolated. That is they exist as stable **entities**, such as driving a car and memorizing phone numbers, that can be called on and used in a fairly predictable manner. The items are only relatively isolated because they can be highly organized and do interact with other items stored in **memory** so that they can be called on as needed during ongoing **events**...

"5. Much of what we store in taxon systems is not initially meaningful. What matters to us is that the **information** can be recalled or the skills used, on demand, irrespective of the **meaning**..."

The authors credit J. O'KEEFE and L. NADEL (1978) for the introduction of the **concept** of so-called "taxon memory systems".

→ **Structural differential**

3495

TAXONOMIES of systems ¹⁾

Systems and their **components** have been classified from different viewpoints by a number of systemists, as for example K. BOULDING (1956), J.G. MILLER (1978) and G. KLIR (1969) in the States and E. JANTSCH (1975), J.L. LE MOIGNE (1977), B. WALLISER (1977) and J. LE-SOURNE (1976) in Europe. P. VOLTES BOU (of Barcelona) (1978) and B. WALLISER (1977) have also proposed a **classification** of **models** types.

L. TRONCALE intended a general classification of cybernetic and systemic **isomorphies** (1985).

As each pursues some specific finality, none of these taxonomies is exclusive of the others, while some are in part coincident. None should be considered as the ultimate truth, as they are merely kind of general **maps** of a very complex **field** and, moreover tend as any classification, to be somewhat procustean: cutting or adding characteristics to suit the general idea. In any case, they are useful and a practical necessity.

CHANG-GEN-BAHG more recently tried to establish a taxonomy of systems theories and a "system of systems sciences", including "**systemology**, **systems methodology** and **systems engineering**" (1990, p.79-107).

→ "**Systems (Basic classes of)**".

3496

TEAM SYNTEGRITY ²⁾

"A proprietary technology developed by Stafford BEER whereby 30 people come together to explore a subject of interest to the **group**" (S. BEER, 1994, p.282)

BEER comments: "The Team Syntegrity technology uses the form of the Icosahedron as the basis for organizing and scheduling the activities and discussions of 30 people around 12 major topics".

BEER derives the term "Syntegration" to name "an event in which the Team Syntegrity protocol is applied" (Ibid)

→ J.van Gigch interesting commentary (1996, p.73-5)

3497

TECHNICAL MACROSYSTEM ^{1) - 4)}

Any system which implies the simultaneous, interconnected and **synergetic** use of different technologies.

Examples are electrical interconnected **networks**, telecommunications systems, railways **networks**, worldwide airlines and aerial traffic **control systems**.

An important characteristic of these systems is the permanent monitoring and **control** of the constantly changing **state** of the **network** and of its **elements**, through an uninterrupted **flow** of **information**.

Technical macro-systems include of course a considerable number of human participants (the **agents** of the technical **management**). They tend to evolve toward increasing **complexity** and some may undergo **phases** of **instability**.

They may also show a growing resistance to **change** becoming **hypercomplex**.

According to A. GRAS, the western way of using techniques based on massive **energy** use is leading **mankind** toward a **network** of evermore expanding and integrated socio-technical macrosystems (TMS) (1993).

This is consonant with **structuration** and **emergence** through energetic **dissipation** as established experimentally by BÉNARD and generalized as a **thermodynamic non-equilibrium process** by PRIGOGINE.

It remains to be seen if these TMS are already acquiring their definitive **structure**, or if the possible future exhaust of mega and macro fossil **energy sources** could oblige them to a global reorganization, based for example in numerous smaller local **energy sources**.

3498

TECHNOCENTRISM ^{1) - 4)}

The supremacy of technicians and technical views in the **management** of a **human system** (enterprise or **organization**).

Technocentrism easily leads to the "let us fix it right now" mentality, leading in turn to a vicious circle of **problems**-generating solutions. Technique, in itself useful or indispensable, should be evaluated within the general **frame of reference** of global **optimization**, and global **constraints**.

→ **Ethnocentrism**

3499

TECHNOLOGICAL DETERMINISM ^{1) - 4)}

"The belief that technology develops by its own laws, that it realizes its own potential, limited only by the material **resources** available, and must therefore be regarded as an **autonomous system** controlling and ultimately permeating all other **subsystems** of society" (K. KRIPPENDORFF, 1986, p.74).

KRIPPENDORFF himself evaluates this belief: "Evidence for the first proposition is largely taken from the natural history of technology, its progressive character and the co-occurrence of independent inventions. Evidence for the second proposition stems from the unwarranted

¹⁾general information²⁾methodology or model³⁾epistemology, ontology and semantics⁴⁾human sciences⁵⁾discipline oriented

generalization that everything that is invented is ultimately installed and ignores human playfulness, individual and collective interests and man's cognitive limitations" (Ibid).

It remains however obvious that the massive uses of technology deeply modifies human individual and collective **behavior**, generally accelerating and densifying **interactions** (Good examples are the car and the telephone, and now, the internet). Such **changes** could eventually lead to a **negative feedback** due to general **overburdening** of **eco-** and **sociosystems**.

3500

TECHNOLOGY ¹⁾ - 4)

The body of **knowledge**, **methods** and tools that allows man to growingly adapt his **environment** to his needs.

While some superior vertebrates invented some primitive techniques, it is man who made technology into an active and overwhelming **transformation** power of his societies, and their **relations** to their **environment**.

This **process** is presently accelerating in an explosive way, putting the whole mankind-planet system in a growing **instability** stance.

Systemics should urgently investigate this **runaway phenomenon**.

→ **Evolutive acceleration**

3501

TECHNOLOGY ASSESSMENT ¹⁾ - 4) - 5)

The **evaluation** of possible future **effects** of some new technology.

According to the UNESCO-UNEP Glossary it uses: "**Methods** and **processes** of projecting, evaluating and predicting possible **short** and **long range** physical, social, economic, and ecological benefits and **costs**, including negative **side effects** and impacts, of introducing a particular technology in general or for a given area of the **environment**" (1983, p.27).

Unfortunately, the growing number of catastrophes from technological origin shows that technology assessment is still much wanting. This is obviously because it is nearly always practiced from an ad hoc and partialized viewpoint.

Two important causes of such situation seem to be:

- Technology assessment cannot be partialized (or **underconceptualized**, in J. WARFIELD's terminology), if it is to be really reliable. Most recent disasters show that, in practice, dangerous or questionable technologies were only assessed by specialists, using narrow, short sighted and **short term usefulness criteria** (C. FRANÇOIS, 1989, p.1101-11).
- Technology assessment has a totally neglected the ethical aspects, and frequently the social ones. This is due to the presently overpowering (and sometimes downright cynical) utilitaristic bias in the dominant cul-

ture. A result is that the possible problems, even when suspected, are frequently and artfully concealed.

In conclusion, technological assessment should be grounded on:

- a) systemic concepts and **methods** to be used to globally evaluate modifications to **complex systems**, and
- b) a **systemic ethics**, concerned with present and future human rights and responsibilities as well as with **ecological** future.

3502

TECHNOLOGY CREATION (Ethics of)

→ **Ethics of technology creation**

3503

TECHNOLOGY (Sustainable) ¹⁾

N. GEORGESCU ROEGEN observes: "Not all technologies... are viable. A technology is viable if and only if the corresponding production **processes** are mutually self-sustaining and also produce a net product capable of maintaining a tolerable size of **population**."

"The test of the **viability** of a technology must be applied to a **steady state**" (1982, p.314).

Sustainable technology is obviously related to **homeostasis** and **autopoiesis**.

3504

TECHNOSPHERE ¹⁾⁴⁾

The growingly interconnected set of man-made **artifacts**

It includes for example factories, administrative buildings, schools, etc, but also mobile artifacts like vehicles and aircrafts and the **network** of roads, railways tracks, airfields, radio and television **links**, etc...needed for **communication** in general

The technosphere is now becoming globally integrated on the planetary **level**

It is steadily evolving under the impact of scientific discoveries and technical innovation. It is also becoming evermore dependent of a massive and permanent supply of cheap **energy**. Such a dependence could imply the need for deep global mutations in the **long-term** future

Moreover, the harmonious **integration** of the technosphere within the planetary **ecosystem** (**ecosphere**) is still an unresolved problem

Finally, the ever expanding technosphere generates deep economic and socio-cultural changes, many of them unforeseen and unplanned

The future **evolution** or final **stabilization** of the world technosphere remains an open **issue**.

3505

TEKTOLOGY ¹⁾

The basic concept of possible systemic **laws** was enuniated by A.A. BOGDANOV in his treatise: "A Universal Organizational Science (Tektoology)" (Moscow, Leningrad, 1925-1929, in Russian).

I. BLAUBERG, V. SADOVSKY and E. YUDIN write: "The basic assumption of tektology as formulated by BOGDANOV is that the **laws** of **organization** of systems are the same for all possible **objects**, both material and ideal, thereby making a generalized formulation of these **laws** feasible: "**Structural relations** can be generalized in the form of schemata just as rigorous as these describing quantitative **relations** in mathematics, and this can serve as the basis for solving problems of **organization** with the aid of **methods** similar to mathematical ones" (1977, p.26).

A. BOGDANOV himself thus defined the program of tektology: "Tektoology must clarify the **modes** of **organization** that are perceived to exist in nature and human **activity**; then it must generalize and systematize these **modes**; further, it must explain them, that is, propose abstract schemes of their tendencies and **laws**; finally, based on these schemes, determine the direction of **organizational methods** and their role in the universal **process**. This general plan is similar to the plan of any natural science; but the objectives of tektology are basically different. Tektoology deals with **organizational** experiences not of this or that specialized field, but of all these fields together. In other words, tektology embraces the subject matter of all other sciences, and of all human experience giving rise to these sciences, but only from the aspect of **method**: that is, it is interested only in the **mode** of **organization** of this subject matter" (1980, p.III).

G. GORELIK, who translated BOGDANOV's book to English, comments: "BOGDANOV insists that the question of **organization** should be considered on a universal scale, for in absence of such an integral approach its solution is "... impossible, because a **part** torn out from the **whole** cannot be made the **whole**, nor can it be understood apart from the **whole**" (Ibid).

Further along, BOGDANOV observes: "It is easy to see that there is a special **correlation** and a deep kinship between **mathematics** and tektology. The **laws** of **mathematics** do not refer to this or that **field** of the **phenomena** of nature, as **laws** of other special sciences do, but to all and any **phenomenon**..." (Ibid., p.46).

In a bout of - possibly protective - marxist activism, BOGDANOV also stated: "For tektology the unity of experience is not "discovered", but actively **created** by **organizational** means: "philosophers wanted to explain the world, but the main point is it change it" said the greater precursor of **organizational** science, Karl

MARX. The explanation of **organizational** forms and **methods** by **tektology** is directed not to a contemplation of their unity, but to a *practical mastery over them*" (Ibid, p.61).

That **tektology** or **systemics** may be used to try to *change* the world is a distinct possibility, but one which should be used with care and restraint, because even **systemic models** are merely *models*.

In any case, this all is clearly a blueprint for **systemics**, in 1922, nearly 30 years before L.von BERTALANFFY seminal paper in the British Journal for Philosophy of Science (1950).

The progressive incorporation within the systemic-cybernetic frame of numerous **isomorphic models** and **laws**, generalized from some specific discipline, has fully vindicated BOGDANOV's fundamental methodological claim.

3506

TELEOGENESIS¹⁾

"Goal formulation" as a property of systems able to generate their own **goals**.

N.A. COULTER Jr. proposed the concept of teleogenetic system, or teleogenetic **control** systems, which "have the capacity to generate their own **goal**" and "exhibit **goal-seeking behavior**", i.e. "searching for a **goal** to seek" (1968, p.85).

According to COULTER, such systems would have the following capabilities:

"1. **Teleological (goal-seeking) behavior**. It should be capable of controlling an **output** quantity in such a way that it conforms to a "**goal signal**"...

"2. **Teleogenesis (goal-formulation)**. It should be capable of proposing **goals** within the range of capability of its teleological **mechanism**.

"3. **Forecasting**. On the basis of sensed **data** about the controlled quality (in the absence of **action** by the teleogenetic system) it should be capable of predicting outcomes if a proposed **goal** is adopted by the system.

"4. **Evaluation**. In terms of **values** (either initially endowed or accumulated by "experience") it should be capable of assigning **worth-values** to the **forecast** outcome spectrum associated with each **goal**, and computing a global worth-function for the **decision process**.

"5. **Decision**. In accordance with some **decision** procedures, the system should be capable of selecting one of the proposed **goals** and committing the system to that **goal**" (p.85-6).

COULTER's proposal does not seem to have been further researched or applied, save quite recently by G.G. JAROS in South Africa (1994, p.5) (see: **Teleos; teleonics**). However, its relation with the **perceptron** and the more recent **self-organizing networks** is obvious.

3507

TELEOLOGICAL CONCEPTS^{1) - 3)}

The general idea of **self-organizing goal-seeking systems**, able to pursue self-defined **goals**, is circulating around in **systemics**, practically since its beginnings. It has been in various cases cloaked in greek apparel (Telos = **goal**, etc ...), a fact that did not necessarily make it more accessible and clearer.

The first source was possibly the Golem, which (or who?) was **goal-seeking**, but not much **self-organizing**. But the model is the human being him/herself, in search for his/her deepest **understanding**.

We may approach the goal concept through the general **synergetic** one of **order-parameter**, "the **macroscopic structure** or **field** emergent out of **interactions** at the more **microscopic level**" or "a **macroscopic** collective **field**, **emergent** at **critical points** out of myriad **interactions** at the **microlevel**", in K DE GREENE words (1994, p.12). Simultaneously, various **networks models** and also experimental devices are now exploring this field.

Hereafter, some teleo-related concepts and **models**.

3508

TELEOLOGICAL EQUATIONS²⁾

Equations in which "**changes**" in the system are expressed not in terms of actual conditions, but primarily in terms of the distance between the present **state** of the system and its final **state**" (I. BLAUBERG et al., 1977, p.51).

BLAUBERG et al. explain: "In other words, the systems under study are described in such a way as to make it appear that the actual **changes** depend upon a final **state** to be attained later" (According to L.von BERTALANFFY, 1971, p.75-80; 139-141).

To establish such equations for any **complex system** seems to be a very tall order.

Obviously any final **state** is necessarily hypothetical in some sense, as well as the precise moment in which it will be reached. It can be stated only within the limits of the supposed or postulated **goal** of the system, when this **goal** can be understood from some characteristics of the system.

A global aphorism like STAFFORD BEER's "Death is **equifinal**", leaves us still quite far from a set of teleological equations that should predict the future **transformations** of a concrete **living system**.

3509

TELEOLOGICAL EXPLANATIONS³⁾

W.R. ASHBY rejects teleological explanations for **behavior**: "It will be assumed throughout that a machine or an animal behaved in a certain way at a certain moment because its physical and chemical nature at that moment allowed it no other **action**" (1960, p.9).

This smacks of **reductionism**. It is really very difficult to explain "intentionality", even in animals. It could be tentatively considered as a **convergence phenomenon** in systems equipped to treat **information**.

However, it is not possible to ignore the following comment by ASHBY: "Never will we use the explanation that the action is performed because it will later be advantageous to the animal. Any such explanation would, of course, involve a circular argument" (1960, p.9).

Still, could the memorized effects of successful previous **feedbacks** not constitute a satisfactory base for the repetition of useful **sequences**?

3510

TELEOLOGY^{1) - 2) - 3)}

"... directed **behavior**" (L.von BERTALANFFY, 1956, p.7).

J.Z. YOUNG describes teleology as: "The study of **goals**, ends or **purposes**" (1974, p.299)

Contrarywise, for D. BOHM and F.D. PEAT: "Put in the form of a **metaphor**: **Mechanism** is teleology" (1977, p.43).

This statement implies the meaning that any **mechanism**, being basically **deterministic**, seems to convey the inevitability of defined future **states**. In this sense, teleology is implied in Newtonian and Laplacian mechanics, without any needed reference to **purpose**, even if the 18th Century illuminists viewed God as the "supreme mechanic and watchmaker".

This is somehow confirmed by BERTALANFFY's statement that teleological **behavior** "... is a form of **behavior** which can well be defined in scientific terms and for which the necessary conditions and possible **mechanisms** can be indicated" (Ibid).

The word "purpose" in YOUNG's definition however opens the door to a wide discussion, as immediately obvious in this comment by O. YOUNG: "... teleology may be taken analytically as a subheading of the concept of **goal**..." (1964, p.79).

Now, what means "directed": directed by what?

And what is a "**goal**"? Is it something merely implicit within the **behavior** of a non-volitive system? And when dare we say that a system is volitive? And, even, what is exactly "volition"?

Obviously, teleology is in many authors heavily contaminated by anthropomorphism.

Another conceptual muddle was cleared by A. ROSENBLUTH, N. WIENER and J. BIGELOW already in 1943: "Teleology has been discredited chiefly because it was defined to imply a cause subsequent in **time** to a given effect. When this aspect of teleology was dismissed, however, the associated recognition of the importance of **purpose** was also unfortunately discarded. Since we consider purposefulness a

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

concept necessary for the **understanding** of certain modes of **behavior** we suggest that a teleological study is useful if it avoids problems of **causality** and concerns itself merely with an investigation on **purpose**. We have restricted the connotation of teleological **behavior** by applying this designation only to purposeful **reactions** which are controlled by the **error** of the **reaction** – i.e., by the difference between the **state** of the behaving **object** at any time and the final **state** interpreted as the **purpose**".

The final **state** is, of course, a *presently desired future state*, inscribed as a reference within the **control structure** of the system. There is thus no future **action** on the present and any paradox is avoided.

The authors add: "Teleological **behavior** thus becomes synonymous with **behavior** controlled by **negative feedback**... The concept of teleology shares only one thing with the concept of **causality**: a **time axis**" (1943, p.24).

As noted by R.L. ACKOFF, this introduced a deep conceptual mutation: "... in mechanistic thinking, **behavior** is identifying what caused it, never its **effect**. In teleological thinking, **behavior** can be explained either by what produced it, or by what it intended to produce... Study of the **functions**, **goals**, and **purposes** of individuals and **groups** has yielded a greater ability to evaluate and improve their **performance** than mechanistically research did" (1991, p.329).

Any **feedback controlled** teleological **behavior** needs, in cybernetic terms, three **components**: a **reference value** (expressing the **purpose** stated into the system), a **sensory function** (needed to measure eventual **differences**) and an **effector function** (needed to make the **control** effective). These are the basic **parts** of any **regulator**.

It should be observed that at least one of the founding fathers of cybernetics, W.R. ASHBY did not accept teleology: "Our **purpose** is to explain the origin of **behavior** which *appears* to be teleologically directed" (1960, p.9).

One wonders which "physical and chemical" factors (see former entry) induced in ASHBY the "**purpose**" to give a purely **deterministic** explanation of **purposive behavior**.

It would seem that teleological views are quite acceptable, for example within the **organizational closure frame** of **autopoiesis**, or P. VENDRYES' concept of **autonomy**, as the capacity of a system to make a **decision** about its **behavior** at any present instant, either by repeating a formerly successful **decision**, or in function of a *presently* (or even formerly) defined **goal** to be reached in the future.

Even ASHBY's own **homeostat seeks(!)** an **equilibrium** point through successive **adjustments**.

The split between the two viewpoints is probably a **semantic** problem that could be summed up as follows: How *purposeless* should a **purpose**, to be admitted as a spontaneously formed **behavioral regulator** in a system.

The final way to get out of this tangle is probably through R. ROSEN's observation that a system may contain a *projective* or **predictive model** (from the pure physiological **level** to the cerebral-mental one) and develop an **anticipatory behavior**, in accordance with what it can predict about possible or probable future **situations**, be these predictions correct or not.

3511

TELEON^{1) - 2) - 4)}

"A goal-directed **process** unit, which stretch over several **levels** and incorporate numerous living and non-living **subsystems**".

This concept has been introduced by G.G. JAROS, of South Africa, who states that it "has been applied to the study of **complex systems** in the diverse **fields** of **education**, social **governance**, business **organization**, technology **assessment**, psychology, health care and music theory" (1994, p.5).

JAROS distinguishes endoteleons, "which connect an upper (outer) **level** to a lower (inner) **level**" and exoteleons "which are directed at the higher (outer) **levels**. At each **level** bundles of both kinds of teleons combine to form doublets. Examples of doublets are the **cells**, individuals, families, **organizations**, **communities** and **societies**" (Ibid).

The similarity with MILLER's **levels** is obvious. But JAROS states: "**Cells**, humans and **organizations** are the result of their **processes** and not vice versa" (Ibid). This could provide the connection with SABELLI's **Process theory**. JAROS, moreover, seems to consider his teleons as **translevel connective** units, not merely **structural-functional** ones at specific **levels**.

In a more recent paper G. JAROS & E. DOS-TAL replace the word "teleon" with the word "*process*" in italics, to differentiate it from the common use of the word.

They define this new "*process*" as "a spatio-temporal arrangement of **actions** forming in an autonomous, **self-regulated** system, as opposed to a simple, non regulated temporal **sequence of actions** the everyday usage of the word "process" tend to indicate"(1999, p. 199)

3512

TELEONICS^{1) - 3)}

"A **systems approach** ... which focuses primarily on the **processes** that characterize **living systems**, rather than on the **levels** and **subsystems** of which they consist".

This approach, developed by G.G. JAROS, attenuates the **dichotomy** between **levels** and the **whole** in systems. It seems more concerned with vertical unity than with horizontal **strata**.

According to JAROS: "In Teleonics, one does not speak of **interaction** between **entities**, but **interaction** between **processes**. By definition, **processes** have some kind of **goal**, end point or destination, which may or may not be intentionally determined. We refer to this "go-for-it" quality as **goal-relatedness**, which can include **goal-seeking** as well as **goal-directed behavior**" (Contribution to the "Primer Handbook", work in progress, 1996)(Th. MANDEL)

It is in any case difficult to conceive **processes** that would not be proper to some **entity**, or entities without **processes**. However, the **concept of process** conveys better the **understanding** of a **time dimension** in systems.

It should be observed that N.A. COULTER Jr., himself inspired by J.E. GIBSON's "**hierarchy** of automatic **control**" proposed in 1968 a "theory of **teleogenetic control** systems" based on **control** systems able "to generate their own **goals**" and "exhibiting "**goal seeking behavior**... as a special **mode of operation**" (1968, p.85).

3513

TELEONOMY^{1) - 3)}

A system's **behavior** characterized by any non-purposeful end-directed **process**.

R. VALLÉE writes: "A **dynamic system** is teleonomic if it evolves *as if* it would aim at a **goal**. It is the case of **cybernetic systems** whose present **state** tends by way of a **negative feedback** to close in toward a **state** to be reached" (1995, p.17).

"The word teleonomy was invented in the fifties by PITTENDRIGH to replace **teleology** in order to get rid of finalism in biology... the difference being that in one case (**teleology**) one deals with **purposeful** end-directed **processes** governed by an "intelligent, designing mind", while in teleonomy one is looking for non-purposeful end-directed **processes**" (H. ATLAN, 1989, p.240).

Still, one wonders about the real **meaning** of an "end-directed **process**" which is not "purposeful", ...or how do we define "**purpose**", "**goal**", "**end**" and the like in such a way as to avoid **ambiguities**.

Moreover, PITTENDRIGH's good intentions did finally not suppressed the confusion: in 1990 still, M. LIU can write: "The notion of **program** permits to escape from this difficulty (i.e.: anthropomorphism), and to conceive teleonomy as a property of life" (p.274), which is alright ... if humans are not considered as **living systems**!

Fortunately, in his Systemic Glossary (in french) E. SCHWARZ gives the following explanations: Teleonomy is "the directional property of the logical **organization** of a system (=directionality) such as any change seems to aim at a future **goal** (rule in an **homeostatic system**, **self-reproduction** in an **autopoietic system**, existence of a **tropism**, a need, a desire, an intention, a goal, a **purpose**, etc...) The goal may even itself evolve in time. One could be tempted to oppose a causal system (whose present state is caused by its past) to a teleonomic system (whose present state seems to be conditioned by a goal). This would be erroneous, as the teleonomic property is itself causal, i.e. the result of the history of the teleonomic system"(1993, p. 13)

Another interesting view is J. MONOD's one, who considered the human central **nervous system** as the most teleonomic system that ever appeared. Its main characteristic is seemingly its **predictive** capacity which gives it the possibility to project in the present a more or less probable forecast of the future. This creates some possibility to control it. (J. MONOD, 1970)

It could be said finally that teleonomy as a concept mainly points to a peculiar link between past and future through a capacity of creating a directive **correlation** through a **feed-forward**. This could be called "teleonomic **coherence**".

→ **Finality; Purpose; Purpose in social systems; Retro-propagation approach**

3514

TELEOS: "Purpose, aim, goal or end" ¹⁾ - ³⁾

This is another neologism introduced by G.G. JAROS.

It seems useful, because it "de-anthropologizes" the value-laden concepts of **purpose**, etc... However, this was not necessarily JAROS intention. He states anyhow: "Any analysis of **teleons** should start with the identification of the teleos" (1994, p.5) ... which of course is relative to the views of the **observer**.

3515

TELESITIC BEHAVIOR ¹⁾

This expression has been proposed by L. THAYER as different from '**teleologic**'. It refers to: "... what man *can* do, even if we have no more evidence for that capacity than what a few men have achieved... The term is not entirely satisfactory, but we need some concept to account for the fact that men, unlike their fellow creatures, can undertake to become (socially, psychologically, etc.) what they *are not*" (1972, p.105).

Man, as a hypercomplex system, has many virtual possibilities that will normally remain unused, but could be waken up by some unexpected **stimulus**.

3516

TEMPLATE ¹⁾

A **pattern** that can be used for replicating some kind of **element**.

This is a systemic **isomorphy** for many types of stable **structures** bearing some specific **function**. Genes in living beings, or **values** and **norms** in **sociosystems**, are templates in their own field of action (L. TRONCALE).

But, how did the first template appear?

According to H. KUHN, it must have been caused by the emergence of repetitive **dissymmetries**, which may have been equivalent to **rules** in the development and self-stabilization of **automata** (1976).

Environmental influences, when permanent or repetitive, may act as templates. Examples are specific **gradients** of humidity or temperature, that may condition **behavior**, for instance of bees or ants.

→ **Symmetry breaking**

3517

TEMPO, PULSE AND RHYTHMS IN SYSTEMS

According to recent research, it appears that perception of time is **discontinuous**

Carolyn DRAKE, of CNRS, R. Descartes University in Paris, "believes that we sample the world roughly twice a second, checking on each sense to see if sounds or sights have changed. She goes on to suggest that we perceive the world best during these pulsed check-ups. It's how we filter out **information** that would otherwise overwhelm us" (T. GURA, p. 33, 2001)

Rhythm would thus be as much a result of internal tempo of our **nervous system**

→ **Rhythm; Time; Synchrony timer**

3518

TEMPORAL HIERARCHIES

→ **Hierarchies (Temporal)**

3519

TENSEGRITY

"The overall tensile **stresses** of the entire system" (S. BEER, 1994, p.13)

This neologism is a contraction of "Tensile (or tensional) integrity", an expression related to BUCKMINSTER FULLER's geometrical concept of the general conditions of **equilibrium** of complex **structures**, based on **structural relationships**.

BEER writes: "According to this, the **wholeness**, the **INTEGRITY** of the **structure** is guaranteed not by the local compressive **stresses** where structural members are joined together, but by the overall tensile **stresses** of the entire system" (p.13).

Tensegrity allows the redistribution of tensions within a **structure** submitted to deformations, provided each **element** in the **structure** (generally speaking struts and wires) can bear both tensions or compressions. Some **structures** of this type can even shift from one shape to another in reaction to external pressure, while still maintaining their general characteristics.

S. BEER relates tensegrity to the general notion of logical (or organizational) **closure**. He derived his concept of **Syntegrity**, as applied to human teams from the tensegrity **model**.

For more about tensegrity, see R. CONNELLY and Allen BACK (1998, p.142-151) and Martin BROOKES (1999, p.43-46).

3520

TENSION

→ **Stress**

3521

Tensor ²⁾⁵⁾

A generalized mathematical **function** for transforming a vector into another vector, irrespective of the **frames of references** used

Tensors are used to map **transformations** from one coordinate system into another

3522

TERM (Short-, Medium-, Long-) ¹⁾

Different **time scales** in **processes**, **rhythms** and **phenomena**.

What short-, medium- and long- means must be clarified in each case. Geological **cycles** are obviously at a different **scale** than living beings, or meteorological **events**.

The really interesting aspects of different, but imbricated **time scales** are as follows:

- **Time** regularities can be observed in most **processes** at different **scales**. In **living systems**, **circadian rhythms** for example, are clearly distinct from seasonal ones, while both are inscribed within the long-term scale of life as a **whole**.
- Short-, medium- and long-term **rhythms** are more or less interconnected, because they correspond to interconnected **phenomena**. **Population cycles** of different species in predators-preys **relationships** may combine to induce a long-term global **cycle**. This also seems to be the case for the different economic and business **cycles**.
- Long-term cycles offer a limited predictive capability as to the progress of the medium and short term **cycles**. This seems to be related to **chaotic determinism**.

The whole subject deserves more intensive study.

See for example "Fractal scaling", "Frequency analysis", "Kondratiev cycle" and "Weierstrass equation".

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

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TERRITORY¹⁾

That part of **space** totally or partially controlled by a **living system**, an **ecosystem**, or a **socio-system**.

K. BOULDING, who discussed the concept of territoriality, wrote that: "It is relevant to the theory of **niche** and to the determinants of **niches**. Thus any **organization** in competition with others will find that its advantage in the **interaction** diminishes as it goes away from some kind of 'home base', so that at some point the advantages of any further expansion fall to zero. This is what I have called the "**boundary of equal advantage**" between two **organizations**, but the concept could easily be generalized. It is these **boundaries of equal advantage** which really define the **niches** of an **ecological system**. Economy has made an important contribution through **location** theory, especially in the work of LÖSCH (1944 and 1954), who demonstrated that, even if we start with **resources** and **population** distributed uniformly in the geographical **field**, the sheer pressures of maximizing **behavior** will force the **field** into **clusters** and **structures** and will indeed create what are in effect **niches** in what previously had been an uniform **field**" (1972, p.69-70).

It should be noted that the pioneering work in **location** theory was made by W. CHRISTALLER in 1923 (1933 and 1937).

→ **Hexagonal space filling, and possibly, fractals**

3524

TESSARACT¹⁾²⁾

A 3-dimensional representation of a 4-dimensional **construct**.

For a quite imperfect impression see a 2-dimensional representation under "**Hypercube architecture**".

3525

TESSELATION²⁾

The subdivision of **space** into a mosaic of regular or irregular shapes, completely covering the **space**.

Tessellations have been widely explored by the Dutch engraver M.C. ESCHER, and the English mathematician R. PENROSE.

They are useful in the study of **modes** of **space** occupation, which probably reflect underlying **fields** of forces, variously **constrained**. They suggest at times very odd **models** which surprisingly may be confirmed by observation, as in crystallography.

→ **See also: Hexagonal space filling**

3526

TEXT¹⁾

"Data with an inherent **pattern**, **structure** or **organization** through which the **meanings** are revealed".

This is a cybernetic meaning for "text", as given by K. KRIPPENDORFF (1986, p.75).

3527

THEMATIC ATTRACTOR¹⁾⁵⁾

A focal **point** around which we center our life experiences and expectations.

It seems that no human being escapes from such "global organizers" in their life. They could also be called "global **behavioral polarizers**".

Some examples are: the lust for power in politicians; the lust for money in businessmen; the fascination with some specific aspect of the "unknown" in high level scientific innovators - or, in the past, geographical explorers; the exploration of pictorial **forms** for painters, or musical ones for composers; etc...

Nobody devoid of a powerful thematic attractor is seemingly able to become a leader or creator in his/her field, nor even a significant achiever in life.

3528

THEORIES as DEDUCTIVE SYSTEMS³⁾

W. ACAR elaborates on R.L. ACKOFF's **understanding** of what is a theory in the following definition (1988, p.172):

"Theory: a *deductive* system comprising

- 1) a **set** of defined and undefined concepts denoted as the "symbolism" or **language** of the theory
- 2) an assumptional or axiomatic foundation denoted as the "postulates" or "hypotheses" on which the theory rests
- 3) A **set** of implicit or explicit formation or **transformation rules**, called the "logic" of the theory
- 4) A **set** of deduced propositions called the "theorems", "**laws**", or "results" of the theory
- 5) A **set** of instances of applications of the results of theorems, known as "**facts**", "consequences" or "implications" of the theory".

ACAR comments: "We now perceive very clearly what the Singerian philosophical school has forecasted, the relativity of our **knowledge** base and the increased use we make of **models**. Both basic and applied research make an extensive use of the **modelling activity**" (p.173).

Deductive theory are basically **algorithmic**. When some new **observations** or **concepts** cannot be reduced to the **structure** of existing theory, this must be modified or abandoned.

It is also clear that a theory is a *conceptual system*, with general characteristics and a kind of conceptual **closure** that mirrors **organizational closure** in living systems.

3529

THEORY ? (What is a)²⁾³⁾

P. BAK writes: "According to one of the most fundamental principles of science, a theory is a statement about some **phenomenon** in nature that in principle can be confronted with **reality** and possibly falsified" (1996, p. 162)

The presence of the word "**reality**" in this sentence puts us on shaky ground (See: "**Ontological Skepticism or Agnosticism**").

BAK pursues, however: "The **description** can be either verbal or mathematical. In physics, we use the **language of mathematics** to express our theories. To confront the theory with **reality**, we solve equations and compare with experiments" (Ibid). One problem with this is that experiments are constructed by the experimenter, i.e. "**reality**" is "doctored" (The famous condition: "**et ceteris paribus**", which defines which **context** is to be neglected as - hypothetically - not relevant). Moreover, theory may subtly influence the **goal**, forms and **interpretations** of the experience.

Anyhow, let us accept BAK's view: "If there is disagreement, we return to the drawing board"

He immediately adds: "When theories are expressed verbally in terms of much less precise **languages**, the confrontation with **facts** is much more cumbersome and leaves space for endless discussions among experts as to what constitutes the better **description**. Sometimes the experimental **observation** itself, without any condensation in more general principles, is viewed as a theory" (Ibid)

Finally, there is no unequivocal way to unload the ? out of our inquiry.

3530

THEORY (Minimal axiomatics of any general)³⁾

D. Mc NEIL describes as follows the minimal axiomatics of any would be general theory:

"1. There is a constitutive core of **concepts** which interrelate mutually with one another at the center of the theory, more in the manner of a **voluntary loop** than of a closed capsule or an aggregate **cluster**.

"2. There is a mutually productive, even a **generative, connection** between the central concepts and the peripheral ones where theory is reduced to practice.

"3. The core of the theory is the minimum algorithmic compression from which **phenomena** described by the theory can be reproduced.

"4. The core of concepts is irreducible in the sense that, although equivalent concepts may be substituted, no central concept can be removed without altering the scope and productivity of the theory or even render it meaningless.

"5. Two or more of the core concepts are complementary in some sense to another.

"6. The central concepts are well-defined, and their connotations harmonize insofar as possible with similar concepts of ordinary enlightened discourse.

"7. The central concepts are expressed at a uniform level of discourse, and different levels of discourse are clearly distinguished and used consistently;

"8. The more general theory relates to less general theories and to special cases through a correspondence principle which acts as a confirmation and a guarantor of the consistency of the more particular theories and of their applications.

"9. Whether explicitly or by implication, the theory describes dynamical fluxes having contours which trace relatively closed loops as well as relatively open links.

"10. Whether in the assumptions or in the expression of the formulation, there are invariants which provide standards for measures.

"11. The theories describe phenomena in the frame of reference of a conceptual space, thus implicitly relating the observer with the phenomena observed" (1993a, p.8).

To establish this list, Mc NEIL inspired himself from MAXWELL's electromagnetic theory and TURING's theory of universal computation (TURING machine).

Point 1 specifies a basic dynamic viewpoint. Point 3 acknowledges G. CHAITIN's work on the subject. Point 4 is obviously related to GÖDEL's incompleteness theorem. Point 6 aims at avoiding useless jargon. Point 7 takes RUSSELL and WHITEHEAD's theory of logical types in account. Point 8 is related to homomorphies and isomorphies. Point 9 is of 1st order cybernetics origin and Point 11 takes care of von FOERSTER's 2nd order cybernetics (of "observing systems").

This array of concepts is a kind of abstract generalization of the dynamic toroidal model that Mc NEIL also proposes. Applied to the concept of a General Theory of Systems it gets it out of the purely structural and static trap.

3531

THEORY OF TYPES³⁾

A logical theory that prohibits self-membership in sets (i.e. no class can contain itself as a member), or more generally logical self-reference in meaning systems, in order to avoid paradoxes.

The Theory of Types was elaborated by B. RUSSELL and A.N. WHITEHEAD in their "Principia Mathematica" (1925).

It introduced within the classical dichotomy "true – false" the meaninglessness escape, saving formerly unsolvable logical tangles.

K. KRIPPENDORFF however observes: "... by exorcising self-reference, the theory of logical types has retarded the development of theory, largely cognitive theory, in areas where self-reference is prevalent. With its focus on circularity, cybernetics has transcended the theory and essentially solved the problems self-reference originally posed" (1986, p.75).

This seems right only for the specific viewpoint of second-order cybernetics, as proposed by H.von FOERSTER.

From this angle, R. HOWE and H.von FOERSTER thus state the fundamental point of theory of types: "The properties of the observer shall not enter into the description of his observations" (1975). With this proviso, Epiminedes, who is a Cretan, has no logical right to make any statement on the Cretans that may include himself, as a source of internal contradiction. (as for example, saying that *all* Cretans are liars).

However, from the viewpoint of autopoiesis, no observer finds him/herself in a position to totally separate him/herself of the observed reality, because any external stimulus entering him/her is perceived in accordance with his/her internal organization.

This is not to deny the theory of types, but, on the contrary, shows the absolute necessity to learn to relativize the conclusions that we obtain from our observations of reality.

Theory of types is clearly related to GÖDEL's Incompleteness Theorem, as well as to BATESON's double bind.

→ Logical types (Theory of)

3532

THEORY (Projective)³⁾

Any theory introducing some unverifiable hypothesis – at least provisionally – in order to solve some difficulties, unsolvable within a former theory.

R. VALLÉE points out a trend in contemporary theoretical and mathematical physics to "replace visible complication by invisible simplicity" (in the words of the French physicist Jean PERRIN). This is the case when "to a complicated theory describing perceived reality within the limits of its possibilities, we substitute a simpler theory, but at the same time we introduce a universe partially unknown in its own nature or because of the limitations of our observation means" (1990b, p.41).

Three different cases seem to be possible:

1. The new theory is validated when new and adequate means of observation become available: This was the case with atomic theory in chemistry, with special relativity in physics and astrophysics and with continental drift or plate tectonics in geology.

2. The new theory is falsified in POPPER's sense by some new experiment. This was the case of the ether theory after MICHELSON and MORLEY's experiment.

3. The new theory is neither validated nor falsified, but introduces some unsolvable epistemological enigma.

VALLÉE describes this last type of theories as "projective" as: "So we go (*back*), through a kind of projection (which justifies the name of projective theories given to this type), from an unobservable world, where we have simple laws (we could say a *logos*) to an observable world with complex laws (Ibid). This concept of VALLÉE is closely linked with his "epistemological subjectivity", a unavoidable condition, according to him, of any observing, deciding and acting system.

→ Ontological skepticism

3533

THEORY and PRACTICE

→ Practice (Theory and)

3534

THERMODYNAMICS (First law of)^{2) – 5)}

This law is also known as Law of the Conservation of Energy. In its original form the 1st law stated merely that in an isolated system, the total quantity of energy remained constant, even when transformed from one form into another (for instance, from mechanical to thermal by friction).

Later on, the law was extended to cover the conservation of the mass-energy complex, as for example in nuclear reactions.

The isolation condition is basic, since relationships with other systems or generally the environment would imply exchanges of energy.

Any isolated system has a characteristic energy level: its internal energy, which cannot be properly measured, since this should imply that the system be not anymore isolated: conceptual problems already lurk!

3535

THERMODYNAMICS (Generalized)^{2) – 5)}

In its original limited sense, thermodynamics covers the relationship of heat with other forms of energy (1st Law).

The progressive decay of high energy into equalized heat led to the concept of entropy and to thermodynamics properly (2nd. Law).

Both the 1st and the 2nd Law apply necessarily to systems and become in this way connected with the notions of organization and flows.

The 2nd Law was given a statistical interpretation by L. BOLTZMANN, in which maximum internal entropy corresponds to perfectly scattered and equal distribution of (thermal) energy. But the notion of entropy led to contradictions related to the possibility of systems to fight the downgrading of their internal organization (MAXWELL's demon paradox).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

These contradictions led in turn to a deeper reflexion about the **interrelations** of the system with its **environment** (SZILARD's "exorcism" on **MAXWELL's demon**, 1929) and it became clear that the **isolated system** is a purely abstract and ad hoc concept.

Any **concrete system** as observed by J.H. VOGEL, is to itself a **black box** that **constrains** its **relations** with an **environment** by specifying **inputs** and **outputs** conditions (1988, p.300).

It was now necessary to explain why and how **concrete systems** could maintain their **organization** against the effects of the **2nd Law**. This was the first stage of PRIGOGINE's research, who explained the ways in which an **open system** could remain organized by importing **energy** from its **environment**, stabilize at the lowest, most "economic" possible **level** its production of **entropy** and exporting this **entropy** to its **environment** (Theorem of minimum **entropy production**).

Remained still to understand how systems of a higher degree of internal **organization** could appear in a universe generally dominated by the **2nd Law**. This was the second stage of PRIGOGINE's work, who used the concepts of giant **fluctuations**, **dissipative structuration** and **bifurcations**, all related to the **dissipation** of a **flow** of **energy**, to explain the **emergence** of upgraded **organization**. In R. LEFEVER's words: "In contact with a **source** rich in free **energy**, the system is able to maximize its exchanges with the **environment** and to enter in an **evolutive feedback**" (1979, p.24).

The whole of thermodynamics is thus part of the fundamental bedrock of **systemics**.

3536

THERMODYNAMICS (Limitations to classical) ^{2) - 3) - 5)}

Seen from the systemic viewpoint, classical thermodynamics presents serious limitations, which have been expressed as follows by I. PRIGOGINE: "... classical thermodynamics is an admirable but fragmentary doctrine... This fragmentary character results from the fact that it is applicable only to **states of equilibrium** in **closed systems**. It is necessary therefore to establish a broader theory, comprising **states of non-equilibrium** as well as those of **equilibrium**" (1978).

E. ZERBST notes that: "These states of **equilibrium** are "memoryless" (KATCHALSKY); dead ends of dynamic **processes**" (1972, p.71). This also implies that even a **homeostatic** system, which is open, finally reaches a state (death!), where it has lost any remembrance of its former functionality.

The essential point is that the concept of **closed system** allows for ambiguous and even erroneous interpretations. In general, but more precisely so in thermodynamics, it would indeed be better to speak about "**isolated sys-**

tem", i.e. a system that interacts *in no way* (exchanging no **matter**, **energy** or **information**) with any **environment**. It is only in such a system that the 2nd Principle of classical thermodynamics can be applied without interferences and lead the system to its final **state** of total **random homogeneity**, in which **entropy** has reached its maximum and no free **energy** is anymore available to perform any kind of work. At that **state** one cannot anymore speak of a system, in view that any **concrete system** is characterized by its **heterogeneity**, its **structures** and its functional aptitudes.

L. BRILLOUIN even stated that the 2nd Law is also useless for the study of many purely physical systems, which has since been confirmed by PRIGOGINE and his school's research on a number of physical and chemical reactions.

3537

THERMODYNAMICS (Linear) ²⁾

Linear thermodynamics, established by L. ONSAGER in 1931, apply to **equilibrium** systems, in which the **flows** are proportional to the **forces** in a **linear** way.

From this starting point did PRIGOGINE derive his **minimum entropy production theorem** (in **open systems**).

In such systems, **entropy** production tends to a stable **level** compatible with the degree of **organization** of the system (More organized systems produce more **entropy**, but "export" it to their **environment**).

The theoretical state of **thermodynamic equilibrium** is the final **limit** of **linear** thermodynamics, when **forces** and **flows** vanish.

3538

THERMODYNAMICS (Second Law of) ⁵⁾

"If a physical system is isolated from its **environment**, than the amount of **entropy** in the system can only increase toward a maximum (never decrease)" (A. RAPOPORT, 1966, p.6).

RAPOPORT adds: "Statistically this means that **isolated systems** tend to **drift** from less probable **configurations** to more probable ones, or, which is the same thing, from more "organized" to more "**chaotic**" ones" (Ibid). (Nowadays, RAPOPORT should probably write "disordered" instead of "**chaotic**", since this last term acquired a different meaning.

As stated by RAPOPORT, the system is here simply a portion of the physical **universe**, being well understood that it is **isolated**, i. e. not receiving **inputs** of any kind from — nor emitting any **outputs** toward its **environment**. This is obviously a perfectly theoretical case, of which only a perfectly abstract **model** can be constructed.

If this point is not duly understood, numerous apparent contradictions arise, particularly in relation to **living** and **social systems**, which, of course are **open systems**, able to maintain and even to increase their internal **organization** thanks to organized **matter**, **energy** and **information inputs** from their **environment** and to the possibility to export **entropy** toward that same **environment**.

Even if both situations are a consequence of the 2d Law, there is a clear-cut opposition between the abstract concept of entropic degradation of **order** in **isolated systems** and the more realistic **model** of **self-organization** through a higher production of **entropy** in **open systems**, particularly living ones. H. and L. SABELLI emphasize both aspects and use the greek word "**enantiodromy**" to characterize their complementarity (1994). SABELLI even redefines the 2nd Law as "the **flow** of all **processes** towards **symmetry**, including as such not only the uniformity of **entropy**, but also the creation of complex **attractors** and **structures**".

I. PRIGOGINE considers that "The second law... provides us with a universal law of **macroscopic evolution**, since the quantity of **entropy** appertaining to the system and its **environment** can only increase in the course of time" (1978, p.11) He has however discovered and discussed the thermodynamic conditions applicable to **irreversible systems**, for which the 2nd law remains in check, at least for a **time**.

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THERMODYNAMICS (The Second. Law of) as an ATTRACTOR ^{2) - 5)}

This concept has been introduced by R. SWENSON (1989, p 189) in the following terms:

"All real-world macroscopic **change** is **irreversible** and hence governed by **attractors**, viz. the **unstability** of **entropy**-producing **processes**. In particular, the 2nd. law of thermodynamics specifies a maximum **entropy attractor**, S_{max} , the macrostate with the maximum number of accessible microstates, for all macroscopic **change** as $t \rightarrow \infty$. In this sense, all macroscopic **change** is:

1. progressive (goes **irreversibly** towards an **attractor**) and
2. goal-driven (the **attractor** is the **goal**)

"The **attractor** drives the **evolutionary behavior** by virtue of the **instability** of all **states** within the **basin** of the **attractor**, but off the **attractor**".

3540

THERMODYNAMICS (Third Law of) ^{1) - 5)}

"All **processes** slow down as they operate closer to the thermodynamic **equilibrium** making it difficult to reach that **equilibrium** in practice".

K. KRIPPENDORFF, who thus states this law, writes that it is also known as the “**asymptotic law**” (1986, p.76). The concept makes sense, but its relations with thermodynamics in general are not clearly explicated.

3541

THERMODYNAMICS (Equilibrium)²⁾

The final **state** of an **isolated system**, in which no internal **gradient** does anymore exist and any coherent **flow of energy** has disappeared.

I. PRIGOGINE writes: “At thermodynamic equilibrium, complete **disorder** is reached and the probability is maximum” (1984, p. 436).

A curious consequence is that an *isolated* system would be completely devoid of any **structure** or **function** and, therefore not be anymore a system.

P. COVENEY states: “... equilibrium thermodynamics cannot... describe **change**, which is the very means by which we are aware of **time**...”

“It is only by virtue of **irreversible non-equilibrium processes** that a system reaches a **state** of equilibrium. Life itself is a **non-equilibrium process**: ageing is **irreversible**. Equilibrium is reached only at death, when a decayed corpse crumbles into dust” (1990, p.50).

However, “**near equilibrium**” should be carefully distinguished from final static **equilibrium**. A system in **near equilibrium** is still a dynamic one: it is able to maintain its **dynamic stability** or **homeostasis**, by using some steady **energy source** from its **environment**.

Apparent **paradoxes** are due to the purely abstract and unrealistic character of the “**isolated system**” concept, and motivated PRIGOGINE's efforts to develop a more satisfactory **thermodynamics of open systems**, either close to **equilibrium** or far away from it.

3542

THINKING (Integrative) : E. MORIN's seven principle¹⁾³⁾

The french philosopher E. MORIN (1999a, p. 99-101) proposes the following seven principles as guidelines for an integrative way of thinking:

1. The systemic organizative principle, which unifies the **knowledge** of the **parts** with the knowledge of the **whole**.

According to B. PASCAL (1623-1662) it is “impossible to know the parts without knowing the whole or to know the whole without knowing in particular the parts”

2. The **holographic** principle according to which “not only the part is within the whole, but also the whole is “inscribed” in the part”: The holographic principle implies the concept of **emergence**
3. The principle of the retroactive **loop** or **feedback**: the cause affects the **effect**, but the effect may well also affect the cause. This principle leads to the **homeostasis** concept

4. The principle of **recursive loop**, which explains that a system reproduces itself without losing its identity. This is the basic concept of **autopoiesis**
5. The principle of **autonomy** and dependence that states that a system is able to maintain its capacity to sustain itself as a well defined entity only if it obtains the needed **inputs** from its **environment**
6. The dialogical principle (also called **antagonistic**) that states the **complementary** of somehow opposed notions, as for example life and death, or in physics wave and corpuscle
7. The principle of **reconstruction of knowledge**, i.e. the recurrent reconstruction within a cultural **frame** of existing knowledge by the individuals

While this is a quite general overview of **complexity**, other viewpoints are also significant, and in no way contradictory, as for example SABELLI's **priority of the simple** and **supremacy of the complex**, or J. MILLER's **taxonomy of living systems**

→ **Frames of reference; Reconstructability analysis**

3543

THREE BODIES PROBLEM^{3) - 5)}

The problem, first considered by H. POINCARÉ (In “Méthodes nouvelles de la Mécanique Céleste”, 1892-99) is to compute exactly the future or past position at some instant of three celestial bodies whose initial positions and velocities are known and which are submitted to Newtonian reciprocal attraction.

POINCARÉ showed that such a **prediction** was not possible by using anyone of the usual **functions**: **linear**, trigonometric, exponential and their combinations. Moreover he demonstrated that a three bodies system may well be **unstable**.

This has been confirmed during the 1960's by KOLMOGOROV, ARNOL'D and MOSER (The so-called **KAM theorem**), who showed that for some values of the **initial conditions**, the **trajectories** are **quasi periodic**, as if they were integrable, but for other **initial conditions**, arbitrarily close, **instabilities** zones do appear (**chaotic zones**), where dynamics are quite more intricate.

This has been confirmed by computing comets and asteroids orbits, which result **chaotic** in the long run, i.e. subject to significant discontinuous **changes**. Very generally the classical newtonian two-bodies problem is an arbitrary **simplification**, obtained by elimination of secondary **perturbations**. Thus **chaotic dynamics** is also a feature of celestial mechanics and, conversely, it appears that Newtonian mechanics may imply non absolutely **deterministic** consequences.

As explained by R. ROSEN, the three bodies problem has wide implications in relation to the **interactions** of **elements** within any system or for groups of interacting systems: “Yet we might argue that we could study such a three-body system by decomposing it into **subsystems**; a two-body system and a one-body system, both of which are solvable in closed form. This does not help us, because the very act of decomposing the original system in that fashion will irreversibly destroy the dynamical **laws** of the original system; in other words, the properties of the **subsystems** prepared in that fashion will have nothing whatever to do with the properties of the system we are interested in. The properties of the **subsystems** will be *artifacts*. Stated another way, a three-body system is simply not the algebraic sum of a two-body and a one-body system”...

“Now biological systems are typically organized in a manner like that of the three-body system; they resist physical **decomposition** into **subsystems** which would possess the same dynamical properties in isolation that they did when connected into the system” (1974, p. 172).

As expressed by J. CASTI: “The essence of the three bodies problem resides somehow in the **linkages** between all three bodies” (1994, p. 41 – emphasis ours). **Simultaneities** of **causes** and **effects**, when complex, cannot be perfectly modeled, and still less so at **long-term**.

This is possibly the clearest indictment of **reductionism** applied to **complex systems**.

3544

THREE R's of Hard Sciences (The)^{1) - 3)}

P. CHECKLAND characterizes the three basic tenets of hard sciences **methodology** as “**reductionism**, **repeatability** and refutation” He states: “We may *reduce* the **complexity** of the **variety** of the real world in experiments whose results are validated by their **repeatability**, and we may build **knowledge** by the *refutation* of hypotheses” (1976, p.128).

Reductionism allows us to “... systematically investigate a few **variables** in the artificially simple world of the laboratory... to ensure that the results will be intelligible and, hopefully, unequivocal” (Ibid).

On the other hand, “The reductionist is the most enthusiastic wielder of OCKAM's razor... explaining the results using the smallest possible number of concepts” (Ibid, p.131 & 128).

Repeatability, is the basic tool for **validation** in hard sciences.

As to refutation, K. POPPER (quoted by CHECKLAND) stated it as follows: “The **method** of science is the **method** of bold conjectures and ingenious and severe attempts to refute them” (Ibid, p.129).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Unfortunately, none of the three R's can be used freely in the study of **living and social systems**.

Reductionism suppresses most of the significant **interrelations** in living or social **networks**.

Experiences – and still more repeated experiences – are possible on **living and social systems** only in a very limited and generally artificialized way.

And, as a result, refutability is hindered, because it is quite difficult to inscribe specific cases in general hypotheses.

3545

THRESHOLD ¹⁾

The point on a curve of **behavior** where a systems **function** crosses the **limit** of its **dynamic stability regime**.

Below this **limit** the system's **behavior** is not fundamentally affected by excessive **stimulations**. Most generally, the various **functions** within a system are oscillating around a standard value. In such a case "... all **states** are equilibrated when some **parameter function** is less than a certain value, and few or none are equilibrated when it exceeds that value" (W.R. ASHBY, 1960, p.168).

The crossing of a **stability** threshold may either destroy the system, or transform it beyond recognition, within a **process** of **emergence**, and towards a different and frequently more complex **level of organization**.

A slightly different understanding of the threshold is "the minimum-required **stimulation**" to trigger a **change** in the **organization** of a **network** (J.von NEUMANN, 1958, p. 55).

In unstable **composite systems** or **networks**, a threshold defines the minimum **constraint** that must be applied in order to break the **networks structure** and start a global **flow** or an **avalanche** in the **network**, which may also lead to a reordering of its **structure**. Close to such a **constraint** threshold, a very small **disturbance** can start a considerable **change**.

In any case, the crossing of a threshold implies a **discontinuity** and a qualitative **change**. A threshold is a "point of no return" to the original conditions.

3546

THRESHOLD OF STIMULATION ¹⁾²⁾

Thresholds are kind of points of no return. They concretize a **discontinuity** and mostly the shift from a quantitative **accumulation process** to a qualitative **change**.

In many **processes** no such **critical change** appears until resistance to change is overridden by multiple- and sometimes massive- repetition of some stimulation.

It is the equivalent of the common sense saying about "the last straw that broke the camel's back".

Many technical and human **disasters** result from a lack of understanding of this **mechanism** of **discontinuous** change and the insufficient **observation of accumulation phenomena**.

→ **Catastrophe; Power laws**

3547

THRESHOLD UNIT ^{2) - 5)}

"The basic **component** of a **neural network** which produces the **output** 1 if, and only if a weighted sum of all its **inputs** exceeds a given threshold" (P. DENNING, 1992, p.426).

DENNING explains: "The **parameters** of a threshold unit consist of a firing threshold *T* and a set of **inputs** weights *w_i*; these **parameters** are not **binary** but can assume any values on the real number line... In this context **firing** means setting the **output** to 1, and the opposite condition, **inhibiting**, means setting the **output** to zero" (ibid).

The effect thus becomes **digital**.

→ **Parallel Distributed Processing**

3548

THROUGHPUT ²⁾

That part of the **inputs** which is transformed by the system's **activity** into **outputs**.

The specificity of throughputs depends on the nature of the system. Throughput is a quantitative measure of the **efficiency** or **productivity** of the system. However, excessive throughputs, when the internal need for **maintenance** of the system is not covered, may lead to its **collapse**.

3549

TIGHTNESS (Excessive) ^{1) - 2)}

The condition of a system whose **constraints** are reducing **variety** to the point of severely limiting its **adaptive** capacity.

K.DE GREENE writes: "... tightly connected **networks** may be more **unstable** in that the effects of **fluctuations** and **perturbations** in **positive-feedback loops** can spread explosively across the entire **field**".

He adds: "Embodiment of rationalized technological **efficiencies** can destabilize the whole system. For example, computerized **program** trading seems to have increased the severity of the october 1987 international stockmarket crash" (1991 b, p. 72).

As shown by DE GREENE in his paper, **rigidity** and fragility in **complex systems** and **networks**, are closely related to excessive tightness.

3550

TIME ^{1) - 3)}

The concept of persistent existence, duration and succession induced by our **perception** of the sequentiality of **events**.

Trying to define time is one of the most vexing task in any lexicographical endeavor. Any definition always turns out to be somehow circular, as in the given one. We should indeed have to define "persistent", "duration", "succession", "sequentiality" and even "**event**", all of which implies time flow.

The following definition from the American Heritage Dictionary shows the same flaw under a different guise: "A nonspatial continuum in which **events** occur in apparently irreversible succession from the past through the present to the future".

Past and future do not exist "*anywhere*", are only imaginary dimensions of our present **consciousness**, while present is fleeting, cannot be stopped or caught.

E.von GLASERSFELD observes that time dimension is expressed by *verbs*. He states: "This springs from the fact that, when we are analysing a verb, we are dealing with a conceptual **situation** which, under all circumstances, is made up of a **sequence** of **discrete operational** steps: it is, in fact, this very sequentiality that makes the **situation** expressible by means of a verb. That this should be so with verbs designating **activity**, **process** or **change** of any kind, seems obvious: and on closer inspection it becomes clear that it is so also with verbs that designate a **state** – for without there being a **sequence** of at least two **operational** steps which yield the same result (i.e. between which there is no relevant difference that might be registered as "**change**"), we cannot speak of "**state**" (1988, p.7).

Time seems to be part of a complex psychic **frame of reference**. It is not really separable from **matter**, **energy** and **space**. As noted by KORZYBSKI, we cannot imagine some **matter transformation** (nor even permanence), **energy** manifestation or **space frame** outside the time dimension.

As expressed by R.L. ACKOFF and F.E. EMERY, time should be "defined by what it does, not what it is in some metaphysical or physical sense" (1972, p.257). This is in accordance with von GLASERSFELD's views.

The following comment by H. PATTEE illustrates at least partly KORZYBSKI's point: "Time in physics is an irreducible concept, but by no means arbitrary. It is one member of the coherent set of concepts, including **space**, momentum and **energy**, that forms the **language** of physical **laws**" (1978, p.59).

Information does not enter in PATTEE's **set**, obviously because it refers only to the **relation** of the **observer** with the **phenomena**, through material or energetic **markers**.

P. MANZELLI for instance, writes: "... the conceptualization of time is principally derived from **energy/information relationships**, that include the sensible experience of the **observer** into the **description** of the global reality" (1993, p.33).

As **information** is a modulation of some forms of **energy**... in time, and as **energy** itself *flows*, we seem finally enmeshed within a **semantic** vicious circle, which possibly indicates that in our groping for a better **understanding**, we are vainly trying to disrupt a unitary cosmic **frame**.

Irrespective of its "real" meaning – for example in **thermodynamic** terms – time is for us basically a **perception**.

W. PANKOW writes: "**Being is becoming**. Self-transcendent systems are time-generating systems" (1976, p.21).

Within the frame of his extended thermodynamics, I. PRIGOGINE (1973, p.561) has finally put some order in this conceptual and **semantic** morass, as he distinguishes "three levels in the description of time:

- time associated with *motion*
- time associated with *entropy* (**irreversibility**)
- time associated with *dissipative structures*"

About the first level he states: "From NEWTON to MAXWELL and EINSTEIN, time was reduced to a **parameter** in the dynamical **description** of the world: **irreversibility** was only a illusion" (1984, p.61).

PRIGOGINE also makes the following all-embracing observation: "... our physical world has a broken temporal **symmetry**. There exist classes of **initial conditions** which are admissible while their time-inverse is not" (1986, p. 207).

The basic fact about time seems thus to be that it is the most basic "**marker**" of cosmic **asymmetry**. This we perceive through its **irreversibility**, but also its **accumulative historical** significance.

Finally, the nature – and even possibly the existence – of time will remain an enigma until someone discovers some mechanism through which so-called 'objective' or 'real' chronological time could be accurately connected with physiologically and psychologically perceived time.

In any case, time is a basic property and **reference frame** of **complex systems**. Time is somehow equivalent to **causality**: it is its guideline.

3551

TIME (Access)¹⁾

The lapse of time needed to activate some **process**, or elicit some **response** in a system.

Access time is very different, according to the **process** involved. It is related to the speed of the **transmission of commands**.

It can sometimes seriously limit the **efficiency** of the system, but it must anyhow always be taken into account.

→ **Access time for a more specific meaning**.

3552

TIME and ENTROPY¹⁾

Entropy establishes the principle of time **irreversibility**. Moreover, it links downgrading of **energy** and **growth** of statistical **disorder** (BOLTZMANN).

But, what about the reverse **phenomenon** of differentiation and growing **organization**? This subject is thus discussed by J.de ROSNAY: "The time of **observation** is indeed arrowed in the direction of growing entropy: thus in keeping with the arrow of conventional time. But what about the time of creative **action**? It seems to be related to a qualitatively different time, apparently reversed by **consciousness** and aiming towards a direction opposed to a entropy's one: the one of growing **complexity**. How to distinguish this direction from the one of conventional physical time?...

"The 'chronocentric' attitude is quite intransigent. It rejects any consideration about **complementary** between two 'qualities' of time in the way former physicists would accept only **evolution** leading to growing entropy and denied any possible **integration** of biological evolution in their theories.

"Chronocentrism adopts an exclusive logic. Either it accept only causal-type explanations and in this case it relies on the principle of sufficient reason and the **objectivity** postulate. Or, conversely, it accepts only finalist explanations based on a act of faith and a subjective approach.

"The critical difference between these two extreme attitudes is that the causal explanation is strongly privileged in our education and our culture, because it allows for demonstration and scientific proof, while finalized explanation does not permit irrefutable demonstrations, nor scientific proofs" (1990, p.210).

If the polarity between **information** and entropy holds and considering PRIGOGINE and his school's research, there is only one "arrow of time", forthgoing. But it has two different and opposed effects, growing **local organization**, combined by a quickening of the **global** pace of entropization.

Furthermore, the **emergence** of an high level of mentalization in man curiously includes the acquisition of **consciousness** of time and of its **irreversibility**.

And finally, time **consciousness**, while a characteristic of individual **brain-minds**, seems to acquire its total dimension only through social **continuity**, as the individual **consciousness** of time disappears with death.

3553

TIME as an Observer's acquired frame³⁾

K. LORENZ writes: "Almost any higher animal has heredity-bound **structures** in the **organization** of its body and its **behavior** that takes into account such inescapable facts as, for ex-

ample, that no two solid bodies can occupy the same place in **space**; that light moves approximately in a straight line; or that effects always follows cause" (1962, p.41).

It is obviously *sequential* chains of causes and effects that *actualizes* time as a **perception** frame. Such sequences must first be experienced by the young animal in order to activate LORENZ "heredity-bound **structures**" and lead to **consciousness** of time's **flow**.

3554

TIME ASYMMETRY¹⁾

The basics of **thermodynamics** imply the **irreversibility** of time.

This was obscured during a long period because classical physics admitted **reversibility**. Moreover the **MAXWELL demon's** paradox did cast some doubts on the universal validity of the **2nd law of thermodynamics** until it was resolved by L. SZILARD in 1929.

I. PRIGOGINE research has now made definitively clear that the progressive construction of **complexity** implies inevitably time's **irreversibility**.

3555

TIME BINDING^{1) - 3) - 4)}

Ability of a system. to maintain the **memory** of past **situations**, to connect it for use in present action and use it to imagine future possible **situations**, and make plans to try to control these when arising.

The concept was introduced around 1920 by the Polish – American semanticist A. KORZYBSKI (1950a, b).

The time binding capacity grew continuously during the global **evolution**, as the **brain** became more differentiated. With man, endowed with a very complex encephalon this mechanism of preservation of **cognitive maps** acquired an absolutely crucial importance:

- psychologically, because it introduces a permanent **coherence** in **behavior** sequences, *possible only within the time dimension*;
- socially, because it introduces the possibility of institutionalization and **prediction**

Moreover, through technical means (**language**, writing, printing and nowadays all the new media for **transmission** and **storage of information**) time binding is transforming the human species into a global entity, endowed as a **whole** with **memory** and **forecasting** capacity.

More generally, time binding is obviously related to the self-replicative capacity of **complex systems**. **Replication** implies the existence of somehow *stored information*, needed to reproduce **components** and their correct **interrelations** (**organizational closure**).

Biological time, as well as psychological and cultural time seems to depend on the *speed* of the the **replication process**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Time binding capacity also seems to increase with the degree of **complexity** of systems. As shown by V. CSANYI, once the replicative and organizational **process** is launched in human groups, the trend to increasing **complexity** seems an inevitable result (1993, p.268).

3556

TIME DIMENSIONS ¹⁾

The different **period** lengths of different **sub-processes** which take place in a **complex system**.

Their **interconnections** produce a very complicated **trajectory** for the global **process** which may look totally **random**, while in reality it consists of a number of superposed and intertwined **time** curves.

The analysis of these latter is however tricky, since it depends either of the hunches of the analyser or of **Fourier analysis**, which allows for any kind of **decomposition**, significant or spurious.

Most of our evaluations are based on a strictly **linear perception** of the **time-flow** corresponding to some elementary **process** (a watch!), or a complex one artificially thus reduced. Even **nonlinearity** is many times perceived as reducible to lawful regularity. We have scant appreciation of the **long-term accumulations** of effects and the possible **catastrophic** (i.e. **discontinuous**) **changes** they may bring along: "The last straw that broke the camel's back".

We thus need to learn that we may face unsuspected **long-term** consequences of our doings, or that others may experiment them, and in some cases, make us pay for it.

It is possible to speak of "short", "medium", or "**long term**", which appear effectively in many statistical senses related to a great variety of **processes**. However "short", "medium" or "long" may have very different meanings according to the type of **process** which is observed and the considered span of time.

3557

TIME DOMAIN ¹⁾

The duration under which a **process** or a system is active.

Systems have very variable duration. Their **transformations** in time can obey different **rhythms** at different moments of their existence.

In some cases they may extend their time domain in an implicit way for a long span after their apparent disappearance, as conveyed by H. PRAT's concept of **aura**.

3558

TIME FRAME ^{1) - 2)}

The span of time decided upon by an **observer** to study the **dynamics** of a system.

T. BAUMGARTNER et al state: "... in many instances the very **choice** of time frame and research setting will determine whether or not, and to what degree, there is apparent system **closure** and **stability** (or their opposites)" (1976, p.39).

Disregarding this apparently obvious prescription has led to numerous disasters, because in many cases, **closure** and **stability** are assumed over *any* span of time.

The unforeseen (believe it or not!) drying of the Aral Sea is a good example.

3559

TIME HORIZON ^{2) - 5)}

"The last year in the future to which a **model** can be run".

This notion is closely related to J. FORRESTER's **Systems Dynamics**.

According to D. MEADOWS et al: "The time horizon may be an important factor in distinguishing between optimistic and pessimistic futures. Both World 3 and the MESAROVIC/PESTEL **models** reveal problems that may occur some time after the turn of the century. **Models** that have shorter time horizon cannot shed much light on such problems. On the other hand, the more analytically oriented and detailed econometric and **input-output models** are probably more useful for **short-** and **mid-term** projections" (1982, p.103).

In any case, **long term models** are normally more uncertain than **short term** ones, because they include not easily verifiable hypothesis about the future **validity** of **long term trends**, as they *seem* to appear from **data** through the modelizer interpretation. Moreover, let us not forget that **complex systems** may unexpectedly show a **chaotic behavior**.

3560

TIME LAG ^{1) - 2)}

A **delay** in the **transmission** of **effects** between different **components** or **subsystems** in a system.

Time lags are basically caused:

- by **operation lags**, corresponding to the time a **component** or **subsystem** needs to process some specific **input**;
- by transport lags, "which arise from the **delays** occasioned by the moving of materials or other stimuli from the neighborhood of the **components** which produce them to the neighborhood of the **components** to which they serve as **inputs**" (W.R. ASHBY, 1960, p.39).
- It may also represent the duration needed for the exhaust of some systems **buffer reserve** which normally compensates external noxious impacts. A good example is the slow acidification of many lakes, whose effects become obvious many years after the onset of the acidifying influences (W. STIGLIANI &

W. SALOMON, 1993, p.38). This last type of time lag is a very dangerous **phenomenon**, because **long term trends** may remain unperceived for very long time and accumulate potentially massive threats, which may be irreversible when they become clearly visible.

Time lags become of cardinal importance in systems with three or more independent **initial conditions**. As these are generally quite unequal, they reduce, up to a point, the general **coherence** of the system and introduce local **determinisms** disconnecting partly and for the duration of the time lag the **components** or **subsystems** from the rest of the system. This is one of the roots of **chaotic behavior**.

The above described condition is proper to any **distributed system**, be it a human social system, or a **group** of interactive robots or computers. In J.P. VERJUS words, for example: "In a **distributed information system**, there are always **transmission** time-lags, which impede that some **message** emitted from somewhere can be known immediately in other places. As a result, at any moment and any place, it is merely possible to know **approximately** the **state** of other places. It is even possible that... two different **events** taking place within the system could be received in different sequential **order** in various different places" (1988, p.1390).

Time lags, which are inherent in **complex systems**, play havoc with **predictability** and sometimes with **design**. They may seriously disorganize systems, because some **effects** may remain hidden for long time and become irreversible before they are observed. As an example, K. KRIPPENDORFF writes: "In modern society, institutional developments tend to lag behind **changes** in **technology**, causing many social problems... and **conflicts**" (1986, p.42). He could have added "and many **ecological** problems".

3561

TIME LAPSE ^{1) - 2)}

A measured time duration.

Apart from the circularity of defining a time notion using "duration" (or for that "extension"), we also have a problem with **measurement**. Taking due account of the relativity problems with clocks, time measured by clocks is adequate for local physical **phenomena**. But the connection with physiological, psychological, and possibly social time is still quite obscure. See **Time of a system (internal)**.

3562

TIME (Object-in-)

→ **Object-in-time**

3563

TIME of A SYSTEM (Internal)^{1) - 4)}

Biological systems – and possibly social ones – seem to possess a kind of “internal clock”, corresponding however to a non-isochronic flow of **time**, different from one system to another and reflecting “circular logic and **operational closure**” (E. SCHWARZ, 1992, p.770).

Internal time has been researched by P. LECOMTE du NOUY (1936) and A. MISSENARD (1940) in biological terms and more recently by B. MISRA, I. PRIGOGINE and M. COURBAGE (1979) in more general **thermodynamic** terms.

Also R. VALLÉE has developed the very similar concept of “...a time intrinsically adapted to a **dynamical system**”, which he studied in “globally exploding **dynamical linear systems**... in diffusion (or heat) equation (and in)... SCHRÖDINGER equation” (1994, p.33-38).

I. PRIGOGINE et al note: “In addition to the NEWTON-SCHRÖDINGER time, we have to introduce a second “internal:” time describing the **relations** (the “**correlations**”) between the particles” (1991, p.3). And, for large **complex systems**: “... the situation is similar to that of radioactive decay, where lifetime has a meaning only for an ensemble of unstable atoms” (p.5).

The subject remains however still obscure and quite in need of more research.

3564

TIME OF A SYSTEM¹⁾

The specific **time** used by a system of a definite type to perform some **process**.

For example, the reproduction **time** of a bacteria in normal conditions is some hours, while the reproduction **time** of a cow is some months.

3565

TIME PERCEPTION³⁾

This is one of the most elusive issue in general, and in systemics in particular. J.J. GIBSON writes: “We should begin thinking of **events** as the primary realities and of time as an **abstraction** from them – a concept derived mainly from regular repeating **events**, such as the ticking of clocks. **Events** are perceived, but time is not” (1986, p. 100).

L.von BERTALANFFY states that: “Experienced time is not Newtonian. Far from flying uniformly (aequilabiliter fluit, as NEWTON has it), it depends on physiological conditions. The so-called time **memory** of animals and man seems to be determined by a ‘physiological clock’...”

“Experienced time seems to fly if it is filled with impressions, and creeps if we are in a state of tedium...”

“With increasing age, time appears to run faster...”

“Correspondingly, the rate of cicatrization of wounds is decreased proportional to age, the psychological as well as physiological **phenomena** obviously being connected with the slowing down of metabolic **processes** in senescence”

The subject was researched in depth by the French biologists P. LECOMTE du NOUY as early as 1936 and somewhat later by A. MISSENARD (1940) (see above).

It should be added that, just as our **space perception** is defined by our physiological characteristics, our perception of time is also related to it: we have no way to perceive too short **changes**, nor too long ones, while the perception scale of other animals (of very short life for example) could be quite different.

3566

TIME POLYMORPHISM¹⁾³⁾

Time is perceived. As such it is essentially a bio-psychological **phenomenon**. However time **perceptions** are very different, apparently in accordance with what is observed.

R.K. BALANDIN (as quoted by V.V. NALIMOV, 1985, p. 179) notes V.I. VERNADSKY's **observations**, according to whom there are three basic different types of time perception:

- in the radioactive **processes** of decay of atoms we perceive a “time of destruction

“(it should be added that this time is not arithmetical, but **semi-logarithmic**)”

- in many processes, there are **periodic** (and sometimes apparently perrenial) returns to the initial **state**. This is a kind of rotation of time“

- in the evolution of living creatures we register a kind of “creation and **development time**”

Balandin wrote: “VERNADSKY frequently wrote about the unity of **space-time**: each type of space possesses its own time. In other words, each geological object has its own **time scale**.(V.V. NALIMOV, 1985, p.. 45)

Nalimov also quotes H.H. PATTEE who (in C.H. WADDINGTON (ed. 1968) signals the existence of a catalytic time (related to enzyme's activity); a cellular reproduction time; an organism development time; an individual generation time; an ecological succession time and an evolutionary time.

Moreover all these authors seem to overlook EINSTEIN's relativistic concept of time. The meaning of time from the **thermodynamic** viewpoint remains yet also obscure.

The ongoing search for the supposedly fundamental basic unit of time at the micro-, nano-, pico-, etc., **level** adds still another element to this conundrum.

As a (provisional) conclusion, it seems obvious from this quite confusing **panorama**, that there is still something very fundamental missing in our **understanding** of time. It is however clearly a problem of perception and **consciousness** (HUSSERL)

→ **Holomovement; Objectification; Present (the everlasting); Time dimensions; Time lag; Time perception; Time resolution level**

3567

TIME RESOLUTION LEVEL²⁾

G. KLIR explains that, within a selected **time frame** for **observation** of a system, it is necessary to establish:

“1. (A) basic time, which may be represented either by the idealized continous real time measured with respect to an idealized initial time instant, or by a suitable periodic time **event** such as a computer clock

“2. (A) defined time, characterized by a suitable resolution level” (1975, p.151).

“Suitability” is, of course defined in correspondence with significant **changes** of the system to be observed. Climatic and meteorological **changes** must be observed on different time resolution levels. This feature implies problems related to interpolations and extrapolations, which may be more or less acceptable, according to the chosen time resolution level, because this latter acts unavoidably as a kind of **data filter** on the registering of the **state transitions**.

3568

TIME SCALE¹⁾

The normal **span** of duration of a system or a **class** of systems (i.e. a species)

Systems have different **life spans**. This has very important consequences for their perceptive capacity and their specific **activity range**.

For each characteristic natural time **span** (for instance, the second, the hour, the day, the season, the year, the millenium, the geological era) some **phenomena** become visible or invisible.

The perceptive capacity of a **living system**, or a **social system** (and possibly, in the future, of artificial systems) stays in a close relation to its own time **scale**. Humans for example are timed to perceive hourly, daily and yearly **variations**, but the micro-second, the second, the century, the millenium or the geological era escape their normal **range of perception**.

3569

TIME SCALES (Differences in)¹⁾

To cover a similar segment of **transformation** or **evolution**, different systems require different spans of chronological **time**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

BLAUBERG, SADOVSKY and YUDIN express: "This **distinction** may be clearly seen in the following example. In giving a comparative analysis of the **evolution** of two biological species such as, for instance, the drosophile and the rabbit, it would be meaningless to attempt to determine the tempo and character of the corresponding evolutionary **process** in absolute chronological units, for the rate of development of these **processes** are incomparable. The modern biologist therefore employs a unit of **measurement** such as the **time** of replacement of one generation by another and the duration of life of a **population**. In other words, analysis does not involve the concept of **time** in general, but that of the specific time of the system" (1977, p.237).

3570

TIME - SPACE NEXUS ^{2) - 3)}

As noted by I. PRIGOGINE: "The legacy of Newtonian mechanics is a concept of the world in which time is essentially a parameter associated with motion. As early as 1796, LAGRANGE called mechanics a four-dimensional geometry" (1973, p.29).

The introduction of a finite velocity for the propagation of light implied that **space measurement** is possible in terms of timely propagation of light. This **understanding** is now currently used in astronomy (light years). This already dawned in H. MINKOWSKI's mind in 1908: "Space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality" (1923, p.78).

Necessarily, if the velocity of light is finite and if there is no infinite velocity in the universe, propagation of effects in space needs time. This is moreover the condition of the simultaneous existence of separate locations in space. This in turn produces numerous independent **initial conditions** at any moment, the basis for **deterministic chaos**.

D. BOHM and F.D. PEAT state with reference to the space-time of relativity: "Again two apparently incommensurable concepts were discovered to have a deeper unity, and **perception-communication** was extended in physics. Indeed EINSTEIN's was one of the most revolutionary steps taken in the history of science" (1987, p.75).

3571

TIME SPANS for REACTIONS ^{1) - 4)}

"The time available to solve **problems**" (W.D. GROSSMANN & K.E.F. WATT, 1992, p.35).

GROSSMANN and WATT observe that, as specific "amounts of **energy** and material **resources**" are needed to solve **problems** in **human** and **ecological systems**, the time spans available for reactions can be very restricted. This is in fact the notorious "too few, too late"

potential **situation** and implies very great risks in our societies mostly unaware of their own **problems**, or at least of the seriousness of the same, generally because of a partialized non-systemic **perception**.

3572

TIME (Thermodynamic) ^{1) - 3)}

L.von BERTALANFFY writes, (in accordance with PRIGOGINE's **open systems thermodynamics** - as stated in 1947): "The consideration of **irreversible phenomena** leads to the conception of thermodynamic, as opposed to astronomical, time. The first is nonmetrical (i.e. not definable by length measurements), but arithmetical, since it is based upon the **entropy** of chemical reactions and, therefore, on the number of particles involved; it is statistical because based upon the second law; and it is *local* because it results from the **processes** at a certain point of **space**" (1969, p.78).

He also writes: "Thermodynamic time is **non-linear**, but logarithmic since it depends on probabilities; it is for the same reason, statistical; and it is local because determined by the **events** at a certain point. Probably biological time bears an intimate although by no means simple relation to thermodynamic time" (1962, p.75).

These ideas seem consonant with research on biological time carried along by P. LECOMTE DU NOUY and A. MISSENERD in France before 1940. This work was based principally on the differential velocities of wounds healing in relation to age. Biological time seems to be not only local, but also variable in relation to astronomical time.

3573

TIME-CONSTANCY ^{1) - 3)}

The postulate according to which the so-called **laws** of nature have not and will not change through time.

A. RAPOPORT observes: "The metaphysics underlying at least classical physical science is founded on the time constancy of physical **laws**. Mathematically this means that the origin in time of equations of **processes** can be chosen arbitrarily. This in turn, implies that no formulation of a physical **law** is satisfactory if *t*, the **variable** which denotes time, appears explicitly as a **variable** in the equations. Translating into old-fashioned philosophical **language**, this means that time alone cannot be a cause" (1968, p.5).

3574

TIME-ENERGY NEXUS in systems ¹⁾

H.T. ODUM makes the following statement: "The replacement **energy cost** increases as more **organization** and **information** is specified in the assemblage of increasing value" (1971, p.56).

This has been made clear by PRIGOGINE in another way, when he showed that a higher **level** or **organization** in systems implies a higher **level** of **entropy production** (even if the system tends to settle down at the lowest possible minimum **production**).

Moreover, once stabilized the systems tend to evidence a slow increase in **self-reproduction** errors. This has been observed, but seemingly not yet explained.

These different aspects show the intimate relation between energy **flows** and time.

3575

TIME-FRAME MECHANISM ^{1) - 2)}

F. KILE discusses this concept in the following way: "A conscious **element** of a system defines a problem. A second conscious **element** in the same system must define the proper time frame for intelligent **action** in solving the problem. This time frame is defined either by setting a type of **binary** switch which allows the system to proceed only so far without responding to the particular problem definition *or* the time frame is defined by setting an **analog** value which gradually decays (or gradually increases) until the appropriate intelligent **problem-solving action** ensues. If there is not some sort of time-frame mechanism, system **activity** will either stop or degenerate into a sort of **Brownian motion**. i.e. the system would become totally disorganized and collapse" (1975, p.3).

This seems to be special case of J. MILLER's **timer**. Any organized **dynamic system** seems to need some **time control** to coordinate its associated **processes** and foster periodic **control of variables**.

3576

TIMEKEEPER (Biological) ²⁾⁵⁾

A biological **mechanism** that ensures the **stability** of the periodic physiological **rhythms**.

This is a particular case of J. MILLER's **timer**.

The biological timekeeper is situated in the suprachiasmatic nucleus, a **brain structure**. It controls for example the **circadian rhythms**.

J. TAKAHASHI and colleagues identified a specific gene situated on chromosome 5 as the biological timekeeper and found it to be active in the suprachiasmatic nucleus.

(Ph. COHEN, 1997, p.16)

3577

TIMER ²⁾

"The **subsystem** which transmits to the **decider information** about time-related **states** of the **environment** or of **components** of the system".

This is one of J.G. MILLER's **20 critical subsystems** in his **taxonomy of living systems**. It was however introduced only in 1990, i.e. 25 years after the original work, in an ar-

ticle by Jessie MILLER (1990), who states: "Living systems, at all **levels**... have an **information-processing** system, the timer. The timer consists of one or more **oscillators** known as clocks or pacemakers, the **phase** of which can be reset. They measure duration or **order** in **time** or underlie **rhythms** of various sorts. The timer **subsystem** synchronizes internal **processes** of the system and coordinates the system with its **environment**" (p.164).

It is very significant that, in parallel with PRIGOGINE's generalized **thermodynamics**, SABELLI's **process theory**, and with **chaos theory**, the MILLERS now also acknowledge the unavoidable need to introduce **time** in our understanding of **complexity**.

The timer can be studied through the system's **life cycle**, its **periodic** variations, and be useful for **forecasting** and **planning**.

3578

TIME's ARROW ¹⁾

The expression was created by A.S. EDDINGTON (1929).

However, in the laws of classical physics and quantum mechanics, it is impossible to distinguish between past and future. (See "**Reversibility and entropy**").

Nevertheless, daily experience shows us that new entities appear "at any moment", only to decay "later on" and that we cannot do without implicit or explicit references to that enigmatic **perception** that we call "time".

In P. COVENEY's words: "...as the physicist Ludwig BOLTZMANN discovered, it is not possible to base the arrow of time directly on equations that ignore it. His failed attempt to reconcile microscopic mechanics with the **second law of thermodynamics** gave rise to the "**irreversibility paradox**" (1990, p.51).

The "legalization" of time's arrow in physics required more than 100 years, in three steps:

1) The introduction by R. CLAUSIUS in 1850 of the concept of **entropy** as a quantity that relentlessly increases in relation to progressive **dissipation** of heat and levelling of internal **energy states** in an **isolated system**.

The formulation of the 2nd Law as an **inequality** implies in fact giving a privileged direction to time.

2) However, as no real systems are absolutely isolated and as they can maintain successfully their internal **organization** through absorption of **energy** from their **environment**, a more realistic approach was necessary. This was done by I. PRIGOGINE with his theorem of **minimum entropy production** in **systems near their equilibrium** (1945) (1947) However, this theorem still explains **stability**, more than irreversible **transformations** and/or decay

3) One more (and decisive) step was taken by P. GLANSDORFF and I. PRIGOGINE (1971). They

showed that **systems far-from-equilibrium** could jump from one **stable state** to one of some alternate others, through a **bifurcation** brought about by **dissipation** of **energy** through giant **fluctuations** that could not anymore be damped.

From another viewpoint, as noted by M. HAAS "Time is perhaps the most ineluctable foe of **symmetry**" (1967, p.71).

It could also be said that time's arrow is the basic vector of **causality**, which could never become manifest in "no time".

In a somewhat more precise perspective, P. MANZELLI states: "The **irreversibility** of natural **phenomena**, i.e. the reality of the arrow of time, can be described... as a fundamental consequence of the evolutive asymmetrical character of the **dynamics** of **matter/information/energy transformations** in nature" (1993, p.234).

As experimental proofs became numerous, it can be admitted that the "arrow of time" is now firmly established in a scientific perspective. What remains now to be found out is how and why *we perceive* time physiologically and psychologically.

3579

TIMING ^{1) - 2)}

The external and/or internal **synchronization** of one or various systems or **subsystems**.

Timing is referred to the **interactions** of **simultaneous** or **sequential processes**. Such **interactions** cannot be completely **random** if the system is to maintain an internal **coherence** and **survival** capability in its **environment**. Timing is an **order parameter** and J. and J.G. MILLER's **timers** are timing devices.

3580

TINKERING ¹⁾²⁾⁴⁾

The **process** of upbuilding of more **complex systems** by introducing some new features in already existing **forms**

This concept has been proposed in his 1982 book by the french biologist F. JACOB as a fundamental process in biological **evolution**.

Tinkering is of course done through "**trial and error**". In **living systems**, "trials" are mutations, and "**errors**" are those **mutations** which are directly lethal or introduce negative factors which finally lead a species into a dead end.

Tinkering seems also to play an important role in the **evolution** of man-made **objects** and techniques in general.

It would be interesting to study the possible role of tinkering in social innovation and evolution.

3581

TIPPING POINT ¹⁾²⁾

The **threshold** at which the **rhythm** of **growth propagation** of some **phenomenon** ceases to be **linear** and becomes exponential (P. MARS-DEN, 2000, p.46).

The concept has been introduced by epidemiologists. It has however a much more general significance for many **phenomena** of similar behavioral characteristics. It should be compared with **avalanches**, **self organized critical systems** and **percolation models**.

It has been proposed also in relation to the **propagation** of **memes** as "mental **epidemics**" (M. GLADWELL, 2000)

3582

TIT-for-TAT STRATEGY ²⁾⁴⁾

In a **game**, a **strategy** that repeats the opponent's previous **behavior**.

This **strategy** can lead either to mutual defection, or to **cooperation**. Some quite unsuspected and interesting alternatives can emerge if some specific **complementary rules** are introduced, as for example, the existence of a longer "historic **memory**" in the players. (C. EMMECHE, 1994, p.92-99)

Such **rules** can better explain **phenomena** of **co-evolution** in different **populations**, or positive **reciprocity** in societies.

3583

TOKEN ^{1) - 3)}

Something that serves as a **representation** of some registered experience.

H.von FOERSTER thus explained his use of this term: "**Objects** and **events** are **representations** of **relations** determined by modes of internal computations: hence "**objects**" appear to reside exclusively (sic) in the **subject's** own experience of his sensory/motor **coordination**. The externality of communal **space** is established within the social **context** of other **subjects**; also **recursively** experiencing "**objects**" as tokens of sensory/motor **closure**. Thus tokens for stable **behavior** are "tokens for **Eigen-functions**" (1981, p.274).

In this extremist view, **objects** (or "**objects**"?) are merely a kind of illusive intersubjective currency. This is acceptable only if one maintains a cautious **ontological** agnosticism, but should not lead to a radical negation of "outside there" reality, which would carry us back to pure **solipsism**.

This must be part of what a French humorist called "les dangers de l'auto" (i.e. of auto-poiesis).

R. GLANVILLE saves the point as he writes about the common view of "**objects**" in se "with their own description built in" that "this meaning is very different from the notion of

"object" as "built through the mutually complementary roles of **observer** and **observed**" (in G. KLIR (Ed.): "Applied General Systems Research, 1978)

In another paper GLANVILLE also stated that a non-observed object "inhabits the **universe** unknown to others" (1978)

3584

TOLERANCE^{1) - 2)}

"The relative capacity of an **organism** to endure an unfavorable **environment** factor or **change**" (UNE, 1983, p.27).

This definition from the UNESCO - UNEP "Glossary of environmental education terms" can be extended to any type of systems. Tolerance is specific to each type of **inputs** for each type of systems. It can vary according to the **state** of the system. It may for instance increase if the system acquires some type of resistance or **immunity**. And it may decrease when it undergoes internal disabling **processes**. Different systems have distinctive tolerance **limits**, for different **inputs**. The tolerance **limits** of different individuals of the same **class** or species generally vary somewhat. This is for instance, how and why resistance tend to develop globally, but slowly, in species, against chemical or drug fighting means.

3585

TOOLKIT PRINCIPLE²⁾

Any new emergent type at a higher **level** of **complexity** in an evolutive **process** is the result of the **integration** of **elements** pre-existing at a lesser **level** of **complexity**.

It avails in fact to a tentative explicative **macro-mechanism** for a generalized concept of **evolution**. This concept has been introduced by W. SCHWEMMLER (1991, p.153, p. 163).

It is in fact a systemic generalization of L. MARGULIS concept of **symbiosis** in cell **evolution** (1981). The concept is also more or less implicit in C. BRESCH work on stages in **evolution** (1977) and in V. CSANYI's **zero-system model** based on **sets of components** which this author calls "**autogenetic system precursors**" (1993).

It could be very useful in the study of the world ecological and social **globalization process** presently in progress.

3586

TOOLS (Conceptual)³⁾

A **set** of concepts that can be used for the study of some **classes** of **situations**.

M. LIU describes as follows the general characteristics of **systemic** and **cybernetic** conceptual tools:

"(1) Global approach tools characterize **interactions**, not **objects**. (They refers for example to: **logics**, **values**, attitudes which specify **relations** between entities).

"2) Such concepts do not describe intrinsic properties of reality,... but indicates some path to characterize some concrete reality.

"3) The conceptual tools emphasize what is general and what is specific. This means that they are not destined to discover only **structures**, which would be **invariant** in whatever **situations**, but are also useful to discover altogether the specific traits of every **situation**.

"4) They are non-disciplinary and apt to characterize the results of very numerous **interactions** related to different aspects" (1989, p.43).

In synthesis, the **systemic-cybernetic** conceptual tools allow us to find new **knowledge algorithms** related to complex **wholes**.

3587

TOP DOWN^{1) - 2)}

The organizational **mode** of a **machine** made of **subsystems** performing **subfunctions** and ordered in such a way as to contribute to the accomplishment of the predefined global **function** of the **machine**.

A good example is the building of a plane, for which a very detailed blueprint has been previously established, describing in great detail the interconnected **functions** of the multiple **parts**, as well as the **parts** themselves.

Such a system is a strongly **integrated** unit. So it is because it has been imagined and constructed in a preconceived way by its creator. It is quite well adapted to the finality assigned to it, but is unable to adapt itself to different **situations**, outside of the **limits** of his predefined finality.

In classical A.I., the top-down approach implies the need for **algorithmic rules**, which, by nature are not adapted to not foreseeable **situations**.

The "top-down" organizational mode is complementary but also antinomic to the "**bottom-up**" one, which is better adapted to social type **situations**. (See more explanations under the heading "**Intelligence (Distributed Artificial)**").

The "top-down" models fit centralized **control** of **interactions**, but tend to ignore the real **complexity** of systems. The "bottom up" **models** tend to become over-complicated, very difficult to integrate in a coherent way and to apply to real **situations**.

Bottom-up construction and top-down **management**, in natural systems, **regulation** or **control** are in a **dialectical** relation.

Any **process** of emergent **complexity** implies recurrent **interactions**, that must be multi-correlated and stabilized.

If taken in a properly dynamic and sequential sense, H. SABELLI's Principle about "**Priority of the simple, supremacy of the complex**" resumes very well the unavoidable **complexity** of the two processes.

3588

TOPOLOGICAL DYNAMICS²⁾

Name given to **chaos theory** by the American School of St. SMALE in Berkeley and the Soviet School of A. KOLMOGOROV, Y. SINAI and V.I. ARNOL'D in Moscow (1989, p.42).

I. STEWART comments: "The very jargon of **chaos** has strong geometrical flavour: **phase space**, orbits, **flows**, **mappings**, **sources**, **sinks**, **saddles**, **attractors**, **bifurcations**, **tangles**, **period-doubling cascades**" (Ibid).

More could be added: **basins**, **separators**, **limits**, **thresholds**, **Poincaré sections**, **trajectory**.

Much of it derives from POINCARÉ's **analysis situs**, the original name of **topology**.

3589

TOPOLOGICAL SPACE²⁾

"A mathematical **structure** on which **continuous processes** can be defined" (R. ROSEN, 1979, p.179).

ROSEN states: "One of the basic problems of topology is to determine whether two such spaces are indistinguishable from one another from the standpoint of the **continuous processes** which may be defined on them: if this is the case, the two spaces are said to be **homeomorphic**" (Ibid).

3590

TOPOLOGY^{1) - 2)}

The branch of mathematics concerned with the study of the properties of the geometric **configurations** which remain **invariant** under **transformation** by continuous **mapping**.

Topology studies properties like nearness (i.e. **neighborhood relations**), deformations through local or global expansion or contraction, equivalence of **forms** from a geometrical viewpoints, etc...

Basically, as stated by R. ROSEN, topology studies the notion of **continuity** (1979, p.179).

That which remains **invariant** in such cases is the proximity **relation** between points, in such a way that there are neither ruptures or fusions as a result of the **transformations**. Thus distortions like pulling, bending, stretching (but not tearing) do not affect the topological properties of figures.

This type of **transformations** is called **homeomorphisms**.

Topology studies qualitative properties related to the relative positions of geometric species, independently of their form or dimensions.

Topology was originally called by H. POINCARÉ "Analysis Situs", or situational geometry and developed by him.

In Bertalanffy's words it is a study of relational mathematics including nonmetrical **fields** such as **networks** and **graphs** theory.

Topology is useful for constructing general **models** of **structures** and their continuous **transformations**.

It is suggestive that some biologists, around 1928-1935, as WOODGER, NEEDHAM and WADDINGTON, sensed the possibility and the need (in BERTALANFFY's words) of a non-quantitative **mathematics**, or "configuration mathematics" which would give priority to concepts of form and order.

It can be used to study basic nonnumerical **relations** between the **elements** of organized systems and the relative **stability** or **unstability** of their **structures**.

Topology concerns itself with **concepts** like: **attractors**, **basin**, **enveloppe**, **partition**, **trajectory**, **vicinity**, etc.... (C. BRUTER, 1974).

Catastrophes, **fractals**, **graphs**, and **groups**, are related mathematical concepts.

3591

TOPOTAXIS¹⁾ - 2) - 4)

The tendency of free **elements** of the same kind to form **clusters** in some limited **region** of the available **space**.

Topotaxis seems to result generally of a growing excess of **population density** in a constrained area.

A classical example is the clustering of **Dictyostelium discoideum** when food becomes insufficient for the increasing **population**. Another is the gregarization of solitary locusts, in similar conditions.

Topotaxis seems however to be a typical systemic concept, as a spontaneous **process** leading to socialization and the genesis of more **complex systems**. The notion could be useful for the study of some **agglutination phenomena** in human societies, as for ex. the formation of megalopolises.

3592

TOROID²⁾

A possible general **representation** of 3-dimensional **phenomena** produced by **field dynamics** (Adapted from D. Mc NEIL).

Helical **dynamics** are the result of **interactions** between **fields**, as in **vortexes**. In abstract, a torus should be a specific **topological attractor** for this kind of movements. However, in many **complex systems**, the imbricated character of their internal **organization** needs be represented by more complex forms, including toroids containing toroids.

Mc NEIL generalizes the **topological torus**, using fully its dynamic character, that results from the complementary opposition of two types of displacements.

And: "... toroidal contours represent dynamic, connected **volutions** rather than the separate, rigid **structures** or the hermetically encapsulated nuggets found in so many conventional **worldviews**" (1993 a, p.15).

Or: "Toroids map the conceptual space into comprehensible orders without resorting to artificial **linear dichotomies** or rigid arrays of pigeon holes" (1993 b, p.14).

Mc NEIL states: "Natural as well as artificial toroids can be generated in many ways other than by the rotation of a plane figure... Toroidal forms can be traced by continuous spirals of **helical dynamics**" (1993 b, p.9).

As to the toroidal dynamics: "In the **context** of a simple toroidal **whole**, the center is the **region** closest to **equilibrium** in the sense that the **meridial** as well as the annular **fluxes** are most concentrated there, much as a whirlpool captures and holds what would otherwise drift along in a stream. The periphery of the toroid is farthest from **equilibrium**, with relatively diffuse currents and cross-currents over relatively broad surfaces" (1993 b, p.16).

Mc NEIL offers the tree, as a general graphical and **dynamic representation** of a toroid. This is at the same time a good **homomorphic model** of real trees and a **metaphorical model** of any system which obtains **inputs** from an **environment**, **metabolizes** them and produces **outputs**. This tree **model** is widely different from the classical tree **model** of **hierarchical organizations**, or a **computer program**: It is not merely the representation of a **structure**, but altogether one of the ongoing **process** or **processes**.

Any **living system** seems to be basically a toroid, and this **model** also fits stellar systems, hurricanes and possibly **ecosystems** and **social systems**.

It should be taken into account that toroids become easily **unstable**.

The now rediscovered **toroidal model** seems to have been first introduced by C.L. WEYHER as early as 1887! (as quoted by C. LAVILLE, 1950, p.54).

→ **Vortex**

3593

TORUS²⁾

"The three dimensional figure described by the rotation of a closed two-dimensional figure across an axis offset from its center" (D. Mc NEIL, 1993 b, p.9).

Mc NEIL comments: "The torus has many consequential **topological** features which a simple sphere or spheroid does not. For the purpose of a systemological definition however, one of the most important of these is the way in which the torus represents a break in the three-dimensional **symmetry** of the sphere. The torus is thus an oriented figure which can **channel**, **direct**, **select** and **control** along its axis, e.g. a duct, a conduit, or a pipe" (1993 b, p.9).

In some sense, the torus differentiates an "inside" from the "outside", and becomes an

abstract **model** for the most various kinds of systems.

For more about the torus, see R.H. ABRAHAM and C.D. SHAW (1988, p.558-73).

3594

TOTAL SYSTEM INTERVENTION (TSI)⁴⁾

"A total **systems approach** to planning, designing, **problem resolving** and **evaluation**" (M.C. JACKSON, 1993, p.1004).

According to R.L. FLOOD and M.C. JACKSON, TSI consists of three phases **creativity**, **choice** and **implementation**. Seven principles are embedded in TSI:

- **organisations** are too complicated to understand using one **management "model"** and their problems too complex to tackle with the "quick fix";
 - **organisations**, their **strategies** and the difficulties they face should be investigated using a range of systems **metaphors**;
 - systems **metaphors**, which seem appropriate for highlighting organisational **strategies** and **problems**, can be linked to appropriate systems **methodologies** to guide intervention;
 - different systems **metaphors** and **methodologies** can be used in a complementary way to address different aspects of **organisations** and the difficulties they confront;
 - it is possible to appreciate the strengths and weaknesses of different systems **methodologies** and to relate each to organisational and business concerns;
 - TSI sets out a systemic **cycle of inquiry** with **iteration** back and forth between the three phases;
 - facilitators, clients and others are engaged at all stages of the TSI **process**" (1991b, p.50).
- The authors give the following examples of systems metaphors to be used, "some of which concentrate on organisational **structure**, (while) others highlight human and political aspects of an **organisation**":

- The **organisation** as a "**machine**" (**Closed system view**)
- The **organisation** as an "**organism**" (**Open system view**)
- The **organisation** as a "**brain**" (**learning system view**)
- The **organisation** as a "**culture**" (emphasis on **norms** and **values**)
- The **organisation** as a "**team**" (unitary political system)
- The **organisation** as a "**coalition**" (pluralist political system)
- The **organisation** as a "**prison**" (coercitive political system)"

They add: "The main aspects of **organisations** highlighted, and those neglected, by each **metaphor** will be disclosed in order to enhance discussion and debate. The outcome (what is

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

expected to emerge) from the **creativity** phase is a "dominant" **metaphor** which highlights the main interests and concerns and can become the basis for a **choice** of an appropriate intervention **methodology**... If all the metaphors reveal serious problems then the **organisation** is obviously in a crisis state" (p.51).

M.C. JACKSON explains the methodology as follows:

"During its **creativity** phase, TSI uses all the systems perspectives or **metaphors** introduced (above) (mechanical, **organismic**, **brain**, cultural, political) to encourage creative thinking about **organisations** and their problems. Some **metaphors** concentrate on revealing problems with organisational **structure**, while others highlight human and political aspects of an **organisation**. What is expected to emerge from the **creativity** phase is an enhanced appreciation of the key issues facing the **organisation** at the time of the analysis...

"The task during the **choice** phase is to choose an appropriate systems-based intervention **methodology** (or **set of methodologies**) to tackle the key issues facing the **organisation** as revealed by the examination conducted in the **creativity** phase. What is required, clearly, is a good understanding of the strengths and weaknesses of the various **methodologies** available and knowledge of what **issues** each is most useful in tackling... The most probable outcome of the **choice** phase is that there will be a dominant **methodology** chosen, to be tempered in use by the imperatives highlighted by dependent **methodologies**. **Choice** of a **systems approach** (or approaches) in this way ensures that it addresses the main concerns of the particular **organisation** and should yield highly relevant and co-ordinated intervention.

"The intervention then progresses to the implementation phase. The specific **methodology**, or **methodologies**, chosen are used according to the special logic prescribed by TSI, in which the positions of 'dominant' and 'dependent' **methodologies** can shift as the intervention proceeds. The outcome of the implementation stage is coordinated **change** brought about in those aspects of the **organisation** currently most vital for its effective and efficient functioning.

"It is important to stress that TSI is a **systemic** and **iterative approach**. It asks, during each phase, that continual reference be made back and forth, to the likely conclusions of other phases" (ibid).

FLOOD and JACKSON themselves offer a critical **evaluation** of TSI, as a theory, as a methodology and as an ideology (?), as well as of its practical utility (1991b, p.241-5).

TSI offers obvious similarities with J. WARFIELD's **Generic Design** and with I.I. MITROFF and H.A. LINSTONE's **Unbounded System Thinking**.

3595

TOTIPOTENCY¹⁾

Ability of some undifferentiated **elements** to generate a new complete system or **subsystem**.

The first demonstration of this strange systemic property was DE VRIES' experiment of dividing an urchin embryo and obtain two perfectly constituted urchins from the separated **parts**. The same **process** is now currently applied in botany in order to obtain from meristemes a number of genetically identical plants.

The regeneration of some animal **parts** when severed (for instance in lizards) seems to show that, in some cases, some cells of mature **living systems** may return to totipotencial undifferentiation (Demonstrated in 1997 through the successful cloning of the ewe "Dolly" in Edinburgh).

A different, but also regenerating **process** is the spontaneous local reconstruction of a partly disabled **network**, as for instance in a **brain** after a not too severe cerebral haemorrhage.

It would be interesting to investigate the relation – if any – of totipotency with **holographic processes**.

3596

TOTIPOTENTIALITY¹⁾

The ability of a **living system** to perform all the **critical subsystems processes** needed for life.

This concept has been introduced by J.G. MILLER (1978, p.18). MILLER makes however a subtle distinction: Only mature systems are totipotencial; in their **growth** period, their **reproducer** is not yet operative.

MILLER (ibid, p.302 for instance) seems however sometimes to use the concept with the **meaning** of **totipotency** (see above).

3597

TRADE-OFF²⁾

"An exchange of one aspect for another and the consideration of the effects of such exchange" (P. VENDRYES, p. 90).

Trade-offs are an interesting aspect of **complex systems behavior**: their wide **variety**, in ASHBY's terms, or **stores of reserves**, in VENDRYES' ones, allow for **choice** among many possible **behaviors** and better potential **accomodation**.

3598

TRADE-OFF DECISION⁴⁾

"A compromise or exchange which **decision** makers must effect when all their **objectives** cannot be carried out at the same time" (J.van GIGCH, 1978, p.119).

The **goal** of trade-offs is **optimization**. However van GIGCH observes that there are false trade-offs, "those that promote "sector improvements" solely within one system or at one system **level**, while neglecting the trade-offs among different systems and systems **levels** and while overlooking the **objectives** of the total system. These false trade-offs are called **suboptimization**" (p.133).

Good trade-offs thus depend on a correct **understanding** of the **interrelations** between **levels** in systems or their **relations** with their **environmental meta-system**.

3599

TRAINING^{1) – 3)}

The **process** of constructing, by **iterative** exercise, any basically automated physical or physiological **behavior**, or mental **algorithms** and **frames of reference**.

Training does not however suppress completely any latitude in **behavior**: it merely tend to define in each case a specific **range** of acceptable **activities**.

Any training is based on **reinforcement** by repetitions. **Learning** is more of a specific training of neuronal connections in the **brain**, mainly in the neocortex.

It seems to be basically a **process** of establishing behavioral or neural **constraints** in order to define in a precise way the potential activities of a system.

→ **Constructivism**, **Habit**, **Hebb's rule**, **Learning**, **Organizational Closure**

3600

TRAINING (Methods of Systemic)^{1) – 2) – 3)}

A set of practical methods to train young people in order to transmit them the **perception** and understanding of **complexity** and, when possible and suitable, the ability to **control** it without harmful side-effects.

The ability to understand complex **situations** by progressive **adaptation** and **accomodation** is natural in human beings. All of our early training as newborns, infants and young children is of systemic and cybernetic nature. Rational **understanding** and analysis intervene only later on. Unfortunately these belated mental acquisitions tend to obliterate the global **perception** and **understanding** or, at least, to impede its use for the study more global **situations**.

In order to maintain it some young Argentine systemists proposed, and experimented with the following **methods** used in:

"**Systemic workshops**: Creating a **transdisciplinary** area of work, using a global approach to real problems as they appear in the everyday life of the young students. This can be done

starting from very general and open thematic cores as for example "youth", "our **environment**", "our neighbourhood", "the **communication media**", etc...

These subjects are developed through debates, excursions, games, videoscreening, audio-visual material, readings, interviews, etc...

"Trade workshops: Training in some specially selected trades as for example integral bakery, paper recycling, vegetable gardening, through which systemic **processes** are presented without any need to use very abstract concepts. Such a work facilitates the **understanding** of three main systems: the person, the society, and the **environment**, in their most general sense. It is an optimal way to develop a better **understanding** of oneself and of natural, physical, mental and social **processes**."

"Workshop with teachers and authorities: Generating a broader thematic and methodological approach by stimulating a more integrated view of reality and a better **understanding** of the global **interrelations** between teachers, pupils, families and the socio-cultural **environment**. In this case, systemic and cybernetic concepts and **models**, applied to real **situations** can be quite useful, if used within the workshops, mostly in an applied non tutorial way."

The experiments met with quite successful results, but no significant support could be found for their extension.

(B. ANGRIMAN, L. FLORIT and A. QUIROGA, pers comm., 1993).

3601

TRAJECTORY ²⁾

A sequence of values of a **variable**, indexed with **time**.

3602

TRAJECTORY in classical representation ²⁾

F. HEYLIGHEN states that, in classical **representation** mode, trajectories are closed "...in the sense that the system must follow a given trajectory: It cannot leave it and follow another trajectory or it cannot enter it from another trajectory, since the **reversibility** and **predictability** of classical **evolution** precludes any branching of trajectories. Mathematically, the trajectory may be called **linearly** closed (i.e., there is a complete, **linear** order **relation** between the points of the trajectory)" (1990a, p.435).

3603

TRAJECTORY of a network ²⁾

The succession of **states** of the network (1991, p.66).

Such a trajectory is usually very complex in networks including numerous **elements**, even when some of these are integrated in stable **subsets** (KAUFFMAN's "**Frozen cores**"). As all the **elements** act simultaneously, the **behavior** of the networks tends to be **deterministically chaotic**, i.e. not really **random** but apparently so. It does become at times practically unpredictable.

3604

TRAJECTORY (Stability of a) ²⁾

J.L. CHABERT and A.D. DALMEDICO write: "The concept of stability may take different meanings. The oldest one, adopted by LAGRANGE, corresponded to the strict **periodicity** of a trajectory. POISSON broadened the notion to the case in which the trajectory comes back not necessarily to its starting point, but an infinity of times in the close **neighborhood** to this starting point" (1992, p.296).

At the end of 19th century, POINCARÉ demonstrated that some trajectories are not stable, i.e. that after diverging from their starting point, they remain forever far from it. He thus introduced the seeds of **chaos theory**.

3605

TRANSCODING ²⁾

"Transfer of **information** from one **code** to another".

Generally, when some **information** enters into a system, it is quickly transcoded. For example, part of the electromagnetic waves are perceived as light by means of a complex conversion through our visual **subsystem**. This **process** may be indirect, for example when the electromagnetic waves are first converted into images through a television tube.

Thus, "**information** must not be confused with its support" (I. BLAUBERG et al., 1977, p.119).

3606

TRANSCULTURATION ⁴⁾

The crossing-over from one culture into another by an individual or a group of individuals.

Cultures are well-defined **human systems**, each more or less, or very different from any other one. A culture "imprints" individuals and make them fit to live within the **human system** they were born in... which may mean unfit to integrate themselves within another one.

Transculturation is a very difficult and frequently a quite traumatic **process**, because the transculturing individual must accept **values**, **norms**, and generally behavioral ways that are different and in many cases contradictory to those she/he learned in her/his mother culture.

A **pathology** of transculturation could be established in systemic terms. It could explain for example fundamentalism and extreme nationalism. It would also probably be very useful in order to avoid so-called "racial" **conflicts**, which seem to be basically cultural ones.

3607

TRANSDISCIPLINARITY ^{1) - 3)}

The general characteristic of **cybernetic** and systemic concepts, **methods** and **models** which provide specialists with a **metalanguage** for the study in common of **complex situations** in systems.

R. RODRIGUEZ DELGADO writes: "Transdisciplinarity is a global **perception** of the ultimate **connection** of all or many disciplines. From this perspective, not only science but all human activities appear as an unitary **whole**, **part** and parcel of the unity of universe. Unity and **diversity** do not appear as opposite concepts, but as complementary perspectives" (Pers. com., 1990).

Transdisciplinarity, as a systemic notion, is quite different from **interdisciplinarity**, or **multidisciplinarity**.

P. CHECKLAND writes: "The call for "**interdisciplinary** teams" to tackle social problems is a popular one, but 30 years' experience in **Management Science** has emphasized that this is not a successful way to tackle such **problems**, rather the fact that it is quite remarkably difficult for specialists from one discipline to understand the concepts and **language** of another.

"What we need is not **interdisciplinary** teams, but transdisciplinary concepts, concepts which serves to unify **knowledge** by being applicable in areas which cut across the trenches which mark traditional academic boundaries" (1976, p.127)

Ch. FRANÇOIS writes: "Transdisciplinarity implies:

"1. The existence of a **metalevel** of **models** and concepts, leading to an integrated **understanding** by every part-taker of the system under study;

"2. The existence of a common **metalanguage**, based on **isomorphies** useful to convey generalized concepts and **metamodels**" (1986, p.115).

The creation, for instance, of a **meta-model** of the possibility to **control** or **regulate complex systems** of any kind (i.e. by **feedback**) may lead the specialists:

- to better understand systems studied by other specialized disciplines
- to collaborate usefully and smoothly in global projects
- in some cases to gain new insights in his/her own discipline and gain much time by avoiding the need to rediscover from scratch concepts or **models** already in existence.

¹⁾general information

²⁾methodology or model

³⁾epistemology, ontology and semantics

⁴⁾human sciences

⁵⁾discipline oriented

The creation of such a crosswise "**meta-tools**" box is possibly one of the most important goal of systemics and cybernetics.

Accordingly, Russell A. ACKOFF states: "Effective research is not disciplinary, **interdisciplinary** or **multidisciplinary**, it is **transdisciplinary**" (1999, p.426)

And: "The **whole** can be understood only by viewing it from all the perspectives simultaneously". And moreover: "Science, I believe, consists of the search for **similarities** among things that are apparently different; the humanities consist of the search for differences among things that are apparently similar. Science and the humanities are the head and tail of **reality**, viewable separately, but not separable" (Ibid, p.427)

FRANÇOIS adds however a caveat: "Let us be very clear and unambiguous: these general concepts or **models** are *identical representations* obtained from *different* specific **situations**, **interrelations** or **processes**. Each discipline studies its own problems in its own terms. However, there generally exist some common traits underlying apparently dissimilar settings or **situations**" (Ibid., p.118-9).

Transdisciplinarity should by no means be taken as a possible substitute for specific disciplines.

K.D. BAILEY, in a recent paper (2001, p. 41-62) explored the multiple traps in the construction of what he calls "concept exportation" across disciplinary **boundaries**. Curiously, while his goal is progress "towards unifying science", he does not use the term "transdisciplinarity", which seems to fulfill exactly his intention and **understanding**.

3608

TRANSDUCER^{1) - 2)}

Some device or system that conveys **matter**, **energy** or **information** from a system, or **sub-system** to another one or, from or to the **environment**.

J. MILLER defines three types of transducers: **input**, internal and **output** transducers, all related to **information** processing. For **matter-energy** transport he uses three other labels, namely: **ingestor**, **converter** and **extruder**, which obviously correspond to the three **information** transducers.

Some authors, as for example T. ÖREN use the concept of "**energy transducer**" in the following way:

"An **energy** transducer is a device that either:

- 1) converts an **input energy** into an **output energy** that is of a different nature than the **input energy** or
- 2) provides **knowledge** about the **input energy**.

An **active transducer** directly generates an **output signal**. A **passive transducer** requires additional excitation **energy**, which is modified by the transducer" (1990, p.12).

ÖREN distinguishes the three following types of transducers:

"The first type of transducer is an **energy-converting** device that can sense **energy** (heat, radiation, or sound) and convert it into electrical, pneumatic, hydraulic, or another form of **output signal**. Examples include microphones, thermocouples and piezoelectric transducers...

"The second type of transducer: 1) receives stimulation from a physical **situation** or condition that is the object of **measurement** (the measurand) and 2) converts that stimulation into a definitely associated **signal** that is more appropriate or convenient as **input** to a **measurement** system.

"A computer **program** is a **knowledge** transducer. Similar to any energy transducer, a computer **program** has an **input knowledge** and an **output knowledge**" (ÖREN, 1990, p.13).

MILLER's **input**, internal, and **output** transducers are other example of ÖREN's third type, but not only in man made **mechanisms**, since they exist at the eight **complexity levels** described by MILLER from the **cell** to the supranational system with various kinds of **energy** and **information inputs** and **outputs**.

Moreover, it seems that the word "**knowledge**", as used by ÖREN in the present context, could be replaced by the word "**information**" (see B. ZEIGLER comments on "**knowledge**" and *internal representation*, 1986).

3609

TRANSDUCTION²⁾

Any **transformation** or **coding process** that modifies an **input** or **output**.

Transduction is generally necessary in order to harmonize the **interrelations** between a system and its **environment**, or between **subsystems** within a system.

3610

TRANSFER FUNCTION

The emission of an **output signal** by a **neurode** after computation of the total of incoming **inputs** from other **neurodes**.

→ **Brain; Parallel Distributed Processing; Stigmergy**

3611

TRANSFER (Inverse)^{2) - 3)}

An implicit **operation** by which an observing and acting system attributes "some of its intrinsic traits... to the part of reality it succeeds in apprehending" (R. VALLÉE, 1990b, p.40).

VALLÉE who introduced the concept, stresses the deformations that the systems **observation process** as well as the **decision** one transmit to the objective **situations**.

He writes: "The theme of "inverse transfer" of intrinsic traits of the observing (and even deciding) system, somehow generalised, gives some elements of answer to the classical interrogation of the intelligibility of the world. If the world is considered sometimes intelligible, not without effort indeed ("Der Herr Gott is nicht bese aber raffiniert" wrote EINSTEIN), it may be partly due to the fact that *our ways of perception, understood in the widest sense, eliminate all that does not fit our mind*. Then through "inverse transfer" some of our intrinsic traits are attributed to the part of reality which we succeed in apprehending" (p.40).

As an example, our classical mathematics could modelize some *chosen* physical properties. However, to explain some others (for example the **3-bodies problem** when it was recognized as a problem in its own right), new mathematics were needed and introduced, starting with POINCARÉ. Later on, important extensions of these mathematics could be used as a new tool to try to understand **deterministic chaos** in general.

It would be interesting to study specific cases of inverse transfer that may probably be observed:

- in superior animals, whose **observation**, **decision** and **pragmatic operators** are at variance with ours
- through cultural differences, in relation to MARUYAMA's **mindscapes**
- during the **evolution** of a same culture through time, for example in relation to the **paradigmatic mutations** described by Th. KUHN (1970).
- in psychologists, who adhere to different theories
- in individuals adepts of different **ideologies**.

3612

TRANSFORM³⁾

In mental **processes**, the **effects** of a **coded** version of some registered **difference**. (Adapted from G. BATESON, 1979, p.109-14)

Any perceived **difference** (i.e any **distinction** made) is not merely registered by the **brain**, but becomes "translated" according to a **code** proper to the **observer**. The code may be differential and even **hierarchical** and produce various "translations".

BATESON comments, referring to KORZYBSKI's **metaphor** about "the map is not the territory": "KORZYBSKI's **map** is a convenient **metaphor** and has helped a great many people, but boiled down to its ultimate simplicity, his generalization asserts that the **effect** is not the **cause**" (p.110).

Of course, but KORZYBSKI carefully mapped the so-called **effects** (plural!), as related to different **frames of reference**, in his **structural differential**.

3613

TRANSFORMATION²⁾ – 4)

1. "A **set of transitions**, on a **set of operands**" (W.R. ASHBY, 1958, p.10).

This is the most abstract formulation of this concept in cybernetic terms. The "**set of transitions**" supposes the existence of a **code**, that can be represented as a **transformation table** (p.11), a **transition matrix**, a causal **network**, or a **graph**.

The observed transformation can be for example: one to one; one to many; many to one; or some more elaborately defined one. The basic idea is to define the way of pairing in general. For details see ASHBY (Ibid).

Another important feature of transformations is that they can operate as a closed (i.e. **cyclical**), or an open set.

→ hereafter: "**Transformation (Principle of non-proportional)**"; "**Translation rule**".

2. "The **process** by which an **input** is changed into an **output**." (B. BANATHY, 1973, p.90).

BANATHY elaborates in the following way:

"**Transformation control and adjustment** are **operations** whereby transformation is monitored. The **information** gathered through monitoring is analyzed and interpreted in order to introduce **adjustments** by which to improve transformation.

"**Transformation facilitation** is a **set of operations** aimed at the continuous energizing and **maintenance** of all **components** that participate in transformation" (Ibid.). (A good example is **catalysis**, in its most generalized sense).

"**Transformation processing** refers to such **operations** as transformation, production, systemization, facilitation and **control**.

"**Transformation production** is a **set of operations** in which the **subject** (i.e. the **component** or **part** we are interested in, or observing) of the system and other system **components** are engaged, interact, and use **resources** in order to accomplish the purposed transformation (of the **subject**...) and thus achieve the **goal** of the system" (1973, p.90).

This last paragraph is redacted in a somewhat partialized way because BANATHY refers himself specifically to the student as the **subject**, i.e. learning **component** in an educational or **training system**.

By **subject**, BANATHY also more generally means "... the entity around which the system is organised and which has to be transformed by the system..." (Ibid). Examples of such a subject could be a school, or a club or any other organization to be transformed by all its participants.

"**Transformation model** is a conceptual **representation of operations** by which the **input** is changed into **output**." (Ibid.)

3. Within a system, the **operation** or **process** by which an **input** is changed into an **output**.

In J. MILLER's **taxonomy of living systems**, this **process** is shared among the following **subsystems**:

a) **processing of matter or energy**: **Distributor, Converter, Producer**;

b) **processing of information**: **Internal transducer, Channel and net, Decoder, Associator, Encoder**. (1992, p.4).

TRANSFORMATION (Baker)²⁾: See "**BAKER's transformation**".

3614

TRANSFORMATION (General Theory of)

Rafael RODRIGUEZ DELGADO in his last work advocates the constitution of a "General Theory of Transformation" (1997, p.27).

Such a theory should coordinate **autogenesis** and **self-organization** (V. CSANYI's "**zero-system**", for ex.); **self-reproduction** (i.e.: MATURANA's "**autopoiesis**"); **growth**; **dynamic stability** and **fluctuations**; **cycles** and **functions**; **catastrophes** in the THOM and ZEEMAN sense; **chaotic processes**; **emergence**; **disintegration**; **synergetics** (HAKEN); **self organized criticality**, and possibly other aspects.

The role of **timers** should be also taken in account and the whole subject framed in classical and Prigoginian **thermodynamics**.

3615

TRANSFORMATION MODEL²⁾ – 4)

"A conceptual **representation of operations** by which the **input** is changed into **output**" (B. BANATHY, 1973, p.90).

BANATHY's definition applies mainly to **planned** transformations in human systems. However, models of transformation in natural systems can also be constructed and be useful to better understand **change** in such systems. Of course, in every case, the model is based on **observations** and hypotheses that should be frequently revalidated.

3616

TRANSFORMATION (Principle of non-proportional)^{1) – 2)}

"As any **structure** grows, the proportions of its **parts** and of its significant **variables** cannot remain constant" (K. BOULDING, 1956, p.71).

BOULDING explains this principle in the following way: "It is impossible... to reproduce all the characteristics of a **structure** in a **scale model** of different size. This is because a uniform increase in the **linear dimensions** of a **structure** will increase all its areas as the square, and its volumes as the cube, of the increase in the **linear dimension**. Thus a twofold increase in all the lengths of a **structure** in-

creases its areas by four times and its volumes by eight times. As some of the essential **functions** and **variables** of **structure** depend on its **linear dimensions**, some on its areal dimensions, and some on its volumetric dimensions, it is impossible to keep the same proportions between all the significant **variables** and **functions** as the **structure** grows" (Ibid).

d'Arcy Wentworth THOMPSON in his fascinating work "On Growth and Form", first published in 1916, scrutinizes a considerable number of consequences of this principle, mainly in biology and engineering. His concept of transformation is basically geometrical: New biological **forms**, for example, are obtained by the deformations of a geometrical grid. But it is clear that the transformation **model** can be adapted and extended to animal and human social **organizations** and explain generally numerous problems linked with gigantism. BOULDING gives some striking examples.

3617

TRANSFORMATIONS (Topological)²⁾

d'Arcy Wentworth THOMPSON observed (1916) that numerous **forms** – principally in biology – while apparently very different, could be related to each other by continuous deformation (**Homotopy**).

N. RASHEVSKY noted that "Topological **analogs** go much deeper in the realm of the living when we observe not merely structural but functional (in a biological sense) **relations**" (1956, p.125).

In support of this, he showed the possibility of the construction of global **graphs** of the biological **functions**, as, for example **assimilation**. This is an interesting generalization of the concept of topological transformation, certainly applicable to very different kinds of systems, as for example human **organizations**.

3618

TRANSFORMITY¹⁾

"The **energy** by unit **energy**"

Being **energy** the total **energy** used to produce the **emergence** of some **field** condition or system, S. ULGIATI et al., state that transformity "has **thermodynamic** significance indicating the position of an item or **process** in the **energy hierarchy** of the universe" (1992, p.1121).

For example "Solar transformity (is) the solar equivalent **energy** directly and *indirectly* required for a joule of product" (Ibid).

In many cases the *indirect* requirements of **energy** in some production **process** are forgotten. This leads to over-optimistic **evaluations** of production in terms of **energy** use, as shown for example by D. PIMENTEL (1977).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3619

TRANSIENT STATE ^{1) - 2)}

"A system state which cannot anymore be occupied again when that system reaches one of its **equilibrium states**" (After K. KRIPPENDORFF, 1986, p.77).

KRIPPENDORFF states that transient states occur during the **growth** of a system, or during **evolutive processes**, and even in social and technological **development**. He adds the very important observation that "**Behavior** involving transient states is also **non-ergodic**" (Ibid).

The contemporary growing general economical, social and political mayhem very probably is a succession of transient states for humanity evolving towards its planetary **integration**. Transient states seem also related to **dissipative processes** in **systems far-from-equilibrium**.

3620

TRANSITION ¹⁾

The **process** of passing from one **state** to another.

W.R. ASHBY states that a transition "is represented by a pair of **states**, one at time *t* and one at the specified time later" (1960, p.248).

A series of transitions generally corresponds to the **trajectory** of some **variable**.

3621

TRANSITION (BÉNARD's) ²⁾

"The crossing from a molecular **chaos** dominated **regime** ... to a much more complex one where part of the **energy** is transferred into macroscopic fluid currents" (adapted from R. LEFEVER, 1979, p.13).

In BÉNARD's experiment – heating a jar of water – this **phenomenon** starts with convection currents within the jar, replacing the simple thermic agitation. When the liquid nears the boiling point, the accelerating convection currents lead to the appearance of **hexagonal structures**: BÉNARD's **dissipative structures**. This **phenomenon** seemed merely a curiosity until PRIGOGINE did generalize it as excess **energy dissipation** through giant **fluctuations** in **systems far-from-equilibrium**. Without such an **energy flow**, "the possibilities of formation of **dissipative structures** are absolutely negligible" (Ibid, p.15).

It is now well established that BÉNARD's transition is a very general **phenomenon**, even in biological and **social systems**, as shown for example by P.M. ALLEN's and colleagues work on **urban systems** (for instance 1984, p.230-248).

→ **Instability (BÉNARD's)**

3622

TRANSITION (Discontinuous) ²⁾

The sudden **emergence** of a new **steady state** after a **bifurcation** in a **system far-from-equilibrium**.

Such transitions appear beyond a **threshold** at a critical distance from **equilibrium** and result from self-amplifying **fluctuations** which cannot anymore be damped and controlled by the system.

These non-equilibrium transitions lead to qualitatively, i.e. evolutive new **states**.

3623

TRANSITION (Principle of asymmetric) ²⁾

"The probability of transition from a less stable **configuration** A to a more stable one B is larger than the probability for the inverse transition" (F. HEYLIGHEN, 1992a, p.5).

HEYLIGHEN comments: "The conjunction of **energy** conservation and asymmetric transitions implies that **configurations** will tend to dissipate **energy** (or heat) in order to move to a more stable **state**" (Ibid).

This is why systems of higher **complexity**, while producing more **entropy** than systems of lower **levels of complexity**, will settle to the least possible **level of entropy** production compatible with their **level of complexity**.

This however does not impede the **process** of **dissipative structuration** in systems submitted to excessive **inputs of energy** in relation to their **level of complexity**. In such cases, **instability** sets in until a new sustainable **level of complexity** is attained. Thereafter, the principle of asymmetric transition is reinstated.

A different way to asymmetric transition described by E. PESSA (1992, p.437) is the "disappearance of **chaotic behavior** and the **emergence** of ordered ones (e.g. **limit cycles**)" through the "mechanism of **noise-induced transitions**". This seems to be closely related to the **nucleation mechanism** described by PRIGOGINE.

→ **Order from noise principle**

3624

TRANSITION PROBABILITY ²⁾

The probability of a shift from one **state** to any other possible one between **elements** which are at least in partly **random interaction** in a system.

This type of **sequential changes** is characteristic of **Markovian** systems and can be represented by a **matrix**.

It can be observed in ASHBY's **homeostat**, and is subjacent in **artificial life automata**.

→ **Markovian System**

3625

TRANSITION PROBABILITY MATRIX ²⁾

A matrix which represents all the possible transitions from one **state** to any other in a **Markovian system**.

G. PASK describes it as follows: "P is an *n.n* matrix with *n*² entries *p_{ij}* and $\sum p_{ij}=1$ rows and columns corresponding with the **states** *J(i)* in a column vector. Each row in the matrix represents the probability distribution obtained by selecting the **state** in correspondence with this row, as we do in multiplication with the column vector *J(i)*. The **state** of a **Markovian system** can be represented as a point in a **probability space** with *n* co-ordinates *p₁, p₂... p_n* one to each **state**. This **space** should not be confused with the **phase space** with *m* co-ordinates related to the **attributes**" (1961a, p.122).

3626

TRANSITION (Rule obeying) ²⁾

A **situation** in which each of the various possible transitions between the different **elements** of a system is constant.

Let us say for example that the **probability** of a transition of the element B to C will always be 0,13 while the transition from element A to D will always be 0,21, in a system where the total of possible transitions between elements is 1. The general basic **model** has been developed by ASHBY (1956). In most natural systems and **artificial life** systems the **probabilities** may vary, being submitted to weight **adjustments** in a **process of parallel distributed processing** (D. RUMELHART & J. MCCLELLAND, 1986)

Rule-obeying processes have been also considered by J. BRYANT (1998), who views the **brain** as a rule-obeying system (p.113-120)

→ **Markovian matrix- Markovian process**

3627

TRANSITION STEP ²⁾

"An **instability** region between two **stable equilibria**" (V. ROWLAND, 1976, p.123).

The **region** thus defined by ROWLAND corresponds to a **discontinuity**, also considered by R. THOM in his **catastrophe theory**.

3628

TRANSITIONS (Register of the) ²⁾

The record of the successive **states** of a system.

Such a record becomes richer with **time** and allows in a progressive way a better **knowledge** of the system's **space of states**.

This **knowledge**, however remains always imperfect for very **complex systems**.

3629

TRANSITIVITY ²⁾

"**Relation** of two **parts** through a middle **part**" (after J. FEIBLEMAN & J. FRIEND, 1969, p.32).

A typical transitive relation is: If $A < B$ and $B < C$, then $A < C$. On the contrary, if $A < B$ and $B > C$, nothing precise can be said about the relation of A to C .

FEIBLEMAN and FRIEND give the following example: "... The **parts** of an apple are transitive, for if the skin ...encloses the flesh, and the flesh encloses the seeds, then the skin encloses the seeds". Conversely "An **aggregation** of three grains of sand is **intransitive**, since the extreme **parts** are not related to each other by a middle **part**" (Ibid).

It is possibly not *that* simple. In **composite systems**, we find a kind of global statistical transitivity. The **set** of the grains of sand, or the **set** of gregarious locusts has an influence on the individuals, whose **behavior** become oriented. And the **set** is obviously composed of these same individuals who acquired some collective properties, due to their **aggregation**.

This is one of these cases where an abstract definition of a concept must be carefully scrutinized, in order to avoid semantic pitfalls.

3630

TRANSLATION^{1) - 3)}

"The act of changing the **signs** in a **message** from one **language** to another" (R.L. ACKOFF & F.L. EMERY, 1972, p.190).

ACKOFF and EMERY state: "Thus translation presupposes **encoding**. The **sender**, **receiver** or intermediary may translate a **message**" (Ibid).

The main problem with translation is the faithful reproduction of **meaning**, because **meanings** are **implicit** in every **language** (which are systems of interconnected and somewhat **fuzzy meanings**) and with specific shades in each case. This is one reason why computer translation is such a difficult job.

3631

TRANSLATION RULE²⁾

"A **bijective function** by which each **element** of the support **set** is assigned another (unique) **element** of the same support **set**" (G. KLIR, 1991, p.53, p.221).

→ **Bijective relation; Transformation**

3632

TRANSLOCATION²⁾⁵⁾

The displacement of an **element** in an ordered **set**.

A **change of location** of a part or element within the **whole** to which it belongs.

The properties of the whole can be quite seriously affected by such a change.

Translocation sometimes occurs in arrays of DNA. An example in micro-biology is the displacement of a gene within a chromosome.

However, this **phenomenon** seems general in character and leads to the reorganization of the system. In many cases its general **organization** and functional **activity** is more or less deeply modified.

3633

TRANSMISSION LAG^{1) - 2)}

"The delay occasioned by the moving of material or other **stimuli** from the **neighborhood** of the **components** which produce them to the **neighborhood** of the **components** to which they serve as **inputs**" (R. ROSEN, 1960, p.39)

The transmission lag is a **time lag**, different from the **operation lag**, also defined by R. ROSEN.

The transmission lags contribute to limit the **coherence** of the system and to render it **heterogeneous** in **space** and **time**. They difficult **coordination** and **control** and may become a desintegrating factor in extreme cases. But they also introduce a measure of leeway for **components** and **subsystems**, which may well be necessary for a better (and even global) **adaptability**.

3634

TRANSMITTER¹⁾

Any device or system which emits **messages** and send them to potential **receivers** through some appropriate **channel**.

The transmitter must code the **messages** in a double way. First, some **energy** must be modulated according to some rules and made apt to be conveyed by the **channel**. This is basically SHANNON's **communication**.

Moreover, the message should "make sense", i.e. have a "meaning", which must moreover have the potential to exert some **trigger effect** on the **behavior** of the **receiver**. In order to achieve this, a second **code** is necessary to establish a system of meanings.

DNA, RNA and neurons are transmitters, possibly in a somewhat **metaphoric** sense. So are radio and TV stations and those people who operate them, i.e. who use electromagnetic **codes** to transmit **semantically** coded **messages**.

3635

TRANSPARENCY^{1) - 3)}

Referred to by J. WARFIELD as "referential transparency": "Referential transparency is required from **methodology** back to theory, and from theory back to foundations. Moreover it is required from applications forward and throughout all three of these components of a science.

"Ultimately, referential transparency is a **description** of a **relationship** between an interpreter and what is to be interpreted..."

"Working against referential transparency is the following formidable collection of difficulties:

- What constitutes a science is implicit;
- Divisions of many **component** concepts are implicit;
- The **universal priors** of science may be treated as implicit, in the presentation of the science;
- definition of concepts by **relationships** may be implicit in the science;
- The underlying basis of arguments in the theory of **sets** may be implicit;
- The underlying basis of arguments in the theory of **relations** may be implicit;
- The foundations of the science are implicit;
- In some instances, especially in newer areas of technology, even the theory is implicit.

In the ultimately reprehensible **situation**, even the **methodology** may be implicit" (1988, p.340).

In brief, the **invisibility** of the implicit can lead to considerable opacity of any **representation** and make its value highly doubtful. This is also a caveat for systemists!

Moreover, transparency also implies a "sometimes implicit aspect of **communication** - (i.e.) interpretive **symmetry** between originator and **receiver** of **communications**, summarized in four essentials:

- "a. That the linguistic terms needed to represent either exist in the **language** or will be created as required;
 - b. that a way to organize the **description** exist or will be created;
 - c. that the **design** of the **representation** will employ the foregoing;
 - d. that the **representation** can be assimilated by both the originator and **receiver**.
- "All these essentials depend on the awareness of basic **language** types" (Ibid).

Some of the reasons why **systemics** is so resisted in some quarters are closely related to WARFIELD's views. There is a wide gap between generalist and specialist **languages**, and this gap should be eliminated by the systemists if they ever want to be listen to.

→ **Frame (mental); Reference frame**

3636

TRANSPARENCY TO ONESELF³⁾⁴⁾⁵⁾

The lack of **perception** of one's own cultural, social and historical conditioning in mental **beliefs** and psychical **processes** as well as behavioral **attitudes**. In fact, the result could be better called "opacity" to whatever else!

J. ORTEGA Y GASSET, in his study of DILTHEY's work (1965, p. 143) writes that man is more alert of his surroundings and much less so of himself. Paradoxically, being transparent or even invisible to himself becomes a very significant **blindspot** in the management of his **relationships** with his material, mental and social **environment**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

This seems to be a fundamental problem specially affecting close-minded and intolerant people. When affecting many people, it can lead to **social pathologies**.

→ **Autogenesis; Autopoiesis; Hermeneutics**

3637

TRANSPUTER⁵⁾

A **component** endowed with some capacity of processing, characterized by four receiving and four emitting **connections**, which enable it to communicate easily with four other transputers.

When interconnected, four transputers constitute a kind of super-transputer with eight possible receiving and emitting external **connections**. This **process** can go on in order to create very complex integrated **networks** with various **levels** of **nested** transputers.

Such **components** are the basic "bricks" of any massively **parallel** integrated systems.

The transputer has some functional similarity with the formal neuron.

3638

TREE²⁾

A branching **graph** used to represent a **hierarchy**.

See: **Graph theory**

3639

TREND^{1) - 3)}

A more or less general regularity in a **process**.

Different trends appear according to **time horizon**. Some are related to **short**, other to median, **long** or very long **term** (in a relative sense). These different **time scales** are interconnected and the **observer** must define the **process level** in which he/she is specifically interested, in view that any trend is normally related to a specific aspect of the **process**. The simple statistic analysis of **data** proposed by **operation research** and called trend analysis, while technically useful, is insufficient and even risky as a **forecasting** tool, if **short term** trends are not distinguished as **fluctuations** in the **longer term** trends (at various **time horizons** at that!).

In systems in **dynamic equilibrium**, the **longer term** trend generally constitutes a limiting **frame** for the **oscillations** of the shorter ones. When the **short term** trend line nears the **limit** (superior or inferior) of the longer one, a reversal of the short one generally takes place and a **short term threshold** is crossed. For this reason, any extrapolation of a shorter term trend is risky and doubtful, if nothing is known about the longer ones.

Of course, the **time scales** of trends **observations** are conventional as they depend on the type of **processes** which are observed.

While one day is a long span in a mayfly's life, one year amounts to practically nothing at geological **scale**. However, even in this case, a sudden discontinuity may happen at any time, as a **chaotic event**: an earthquake produced by the slow **evolution** of a geological fault.

Short term trends may appear as being **random** if related to **long term** ones. However, they may well depend from some micro-**determinism** whose visible expression may even be statistical. In this sense, M. BELIS states: "During the **progress** of some **phenomenon**, the necessity, as dominant trend, opens its way through the multiplicity of fortuitous **events**" (1987, p.59).

While no prediction can ever be absolutely guaranteed, the **observation** of **long term** trends combined with shorter ones is the most reliable tool at our disposal.

3640

TRENDS (Types of)^{1) - 2)}

In the study of system's processes, it becomes very important to distinguish clearly between different types of trends:

- Linear or nonlinear
- asymptotic
- exponential, or logarithmic
- logistic
- cyclical

It is also of significance that some section of a curve, observed within a too short time bracket, may lead to erroneous interpretations concerning the trend as a whole.

3641

TRIAD²⁾

1. A group of three **elements**, normally of the same kind
2. Two interacting systems that produce a third one at a higher **level of complexity**.

Only this second definition is of real interest, because it describes the most elemental building block of any kind of systems. This **process** was described by C.S. PEIRCE as "thirdness".

3642

TRIADIC RELATION²⁾

The **semiotic relation** between **object** and interpretant through **sign** or **symbol**.

The triadic relation was the great discovery of C.S. PEIRCE, according to whom "....but one triadic **node-type**, with two in-branches and one out-branch is necessary for infinite **variety of structure**" (Quoted by H.M. PAYNTER, 1968, p.76).

Many contemporary developments as for example **general semantics** (KORZYBSKI), **learning matrixes** (STEINBUCH), **constructivism** (von GLASERSFELD), **generic design** (WAR-

FIELD), **process theory** (SABELLI) have been, directly or not, influenced by the triadic model.

The basic triadic act is **naming**, i.e. creating a **symbolic** bridge between **subject** and **object**. Obviously, it is the **subject** who **constructs** the bridge. The ignorance of the naming act and its relative value, induces **ontologic** absolutism with its aftermath of logical, psychological, conceptual and practical problems. As a result, J. WARFIELD insists in his lectures that "Questions are superior to assertive hypotheses as bases for scientific study" and that "Every question involves **contextual** implications" and if and when a point can be reached "where there is no contextual implication (we reach) the axiomatic domain" (pers. comm.).

Of course, within the axiomatic domain, we cannot speak about anything concrete: we have reached mental **organizational closure**. No systemist should ever forget this when constructing a **model**.

F. FRISCHKNECHT and J.van GIGCH have used an "Information-System-Processing triad" as the "Common core of human disciplines" (1989, p.239-252).

3643

TRIADICITY^{2) - 3)}

The union of opposites to form a new **element**.

This concept, used by J. WARFIELD and H. SABELLI, originates in C.S. PEIRCE's "thirdness", implying a (**semiotic**) mediating third **element**, the **symbol**, in-between **object** and **subject**. This is very different from HEGEL's synthesis. PEIRCE's idea is thus expressed: "The logical postulate for explanation forbids the assumption of any absolute. That is, it calls for the introduction of thirdness" (in J. HOOPES, 1991, p.187).

Escaping from limited **duality** and resulting dichotomies, triadicty is a very simple combinatory **algorithm**, basic for any systemic construction, as it introduces the notion of multiple **relationship**, supplementary to merely dyadic **linear** ones.

E. SCHWARZ explicits triadicty as follows: "Any existing system, a bacteria for example, has two plus one aspects: Its anatomical physical **structure**..., the abstract non visible **network** of **causal relations** between its **parts** and **processes**, which is responsible for its functioning, and the **cell** itself as a complex **whole**, as a **totality** without which the **parts** would not work, would have no meaning. We believe that these three aspects: physical **structures** and **fluxes** in **space** and **time**; logical organizational **networks** of abstract **relations**; and existent **totalities**, have different **ontological** status, and correspond to deep universal **categories**..." (1994, p.758).

This leads to an "interactive, non-a (i.e. **non-aristotelician** in Korzybski's vocabulary) ternary, conjunctive logic, in which the **interaction** between two terms generates a third and new **holistic** term including, integrating, and of another nature than the two parents and the relation" (p.771).

3644

TRIAL and ERROR¹⁾

An empirical **method** tending to solve some problem or establish some theory through repeated experiments, reducing progressively the **uncertainty**.

Trial and errors **methods** are costly. One of the uses of **systemics**, as proposed by L.von BERTALANFFY, is to guide this type of research, using **metaphors**, **analogies** and, if possible **homomorphies** or, better still **isomorphies** with problems already solved in other disciplines. General **models**, as for example **regulation by feedback**, **dynamic stability**, **dissipative structuration**, etc... may give an insight to the experimenter, aiding her/him in looking for some specific features. Of course such possible short-cuts should be used prudently.

3645

TRIFURCATION^{2) - 3)}

The creation of a third dimension by co-creative **interaction** of the opposites.

This concept has been introduced by L. CARLSON-SABELLI and H. SABELLI, principally in psychotherapeutics.

They state: "Seeking the trifurcation of opposites serves to understand **patterns** that are otherwise obscured by the tendency to think in pairs of opposites" (1994, p.681).

Trifurcation is the dynamic correspondent of **triadicity**.

→ **Dichotomy**

3646

TRIGGER¹⁾

Some **stimulus** or **disturbance** which produces a chain of **responses** in a system.

Different from a simple **stimulus**, the trigger starts a whole **process**, which may propagate itself far from the first **receiver** and during a long **time**, including effects whose relation with the first impact is far from obvious.

The trigger **process** is sometimes at first apparently insignificant. While it may not be clearly perceived, nor understood when it happens, it has sometimes the potential to wholly transform or even destroy a system.

In **risk analysis** or **assessment**, a good study of as many as possible typical trigger incidents leads to a better earlier **forecasting** potentiality of possible **disasters** (or in cases, positive developments) in the making.

3647

TRIGGER EFFECT^{1) - 2)}

An initially small variation in a **process**, which may initiate an **amplifying mutual causal process**.

A trigger effect may, in some cases, "give rise to rapid and unexpected **changes**" (F. ROBB, 1989, p.54).

It corresponds to the sudden **dissipation** of a quantity of potential **energy**, many times in a quite explosive way. Of course, a potential for **instability** must exist, if **regulation by negative feedbacks** and **homeostasis** are to be overcome.

Being the case, the onset of growing and eventually, giant **fluctuations** may lead to the eventual destruction or **transformation** of the system.

Trigger effects come in very different **scales** in **time** and **space**. The most insidious are the ones resulting from a long and slow **accumulation** of some **stress** in the system, as for example the sudden rupture of equilibrium in a seismic fault, or arterial embolism resulting from a blood clot.

At the planetary system level, man's **brain** may be the most important source of trigger effects, due to its very high rate of **energy** processing.

→ **Criticality, Nucleation**

3648

TRIGGERING QUESTIONS²⁾

Those questions that are innovative and trigger new viewpoints or an **inquiry** into some formerly unsuspected issue. The paradigmatic example is SOCRATES' maieutics

→ **Brainstorming; Interpretive structural modeling**

3649

TRIVIALIZATION¹⁾

The **transformation** of the **behavior** of a system from more or less unpredictable to predictable.

The **concept** has been introduced by H.von FOERSTER.

He observes that **complex system** are generally speaking **non-trivial**, in that the same **input** does not necessarily produces the same **output**.

He notes that we mostly try to construct **trivial machines**, i.e. **machines** whose **behavior** will respond to our expectations because we built them along **deterministic rules**. We also try trivialize our **environment**: "The discovery of agriculture is the discovery that some aspects of Nature can be trivialized" (H.von FOERSTER, 1981, p.302).

He adds however: "While our preoccupation with trivialization of our **environment** may be in one domain useful and constructive, in another domain it is useless and destructive. Trivialization is a dangerous panacea when man applies it to himself" (Ibid).

As an example of trivialization he gives the way our system of **education** generally tends to uniformize and standardize students: "Tests are devices to establish a measure of trivialization. A perfect score in a test is indicative of perfect trivialization: the student is completely predictable and thus can be admitted into society. He will cause neither any surprise nor any trouble" (Ibid).

It seems however that the progress of **complex systems** toward a superior degree of non-triviality must be paid for by a trivialization of their **environment** (perhaps an unavoidable consequence of the **2nd. principle of thermodynamics**).

3650

TROPHIC NET

The net of **interconnections** in an **ecosystem** between the **resources** and their users (micro-organisms, vegetals and animals)

Practically in any ecosystem there is a multiplicity of resources (energetic, mineral, spatial) and users, most of them direct (or primary) users and various **levels** of indirect users. Many or these become in turn resources for the higher levels users, that must be considered as **predators**.

In a trophic net, the same resource can be used by different users and, conversely a specific user can use various types of resources.

The trophic net includes also **wastes**, that are generally **recycled** by some specialized users and are reincorporated as primary resources. The general motor of the net is **energy**, normally solar, in a direct or indirect way, but also sometimes geothermal.

The trophic net is in fact a complex **network** wherein some **correlations** are impossible or prohibited, and others possible in some ways and under some conditions.

It can be represented by **graphs**, more or less complex according to their **aggregation** or **disaggregation** levels.

Trophic nets are generally **nonlinear**. A vegetal or animal species can be eaten by different predators. Conversely the same predator may eat different preys.

This explains some failures in biological **control** of pests: An introduced species may very well switch to a prey different from the one it was supposed to feed on.

Also, the evolution of **populations** can turn **chaotic** if some **instability threshold** is crossed. In such a case also the global trophic net can be deeply- and sometimes, irreversibly- disturbed

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Most trophic nets have been deeply altered by man, who pretends to be the global and universal user, generally without a good **understanding** of their local and/or general conditions of **dynamic stability**. As a result, crashes and **collapses** could become inevitable and quite disastrous.

The whole subject has been exhaustively researched by some ecologists, as for instance the Catalan R. MARGALEF (1982)

→ **Entropy production; Feedback; Parasitism; Regulation; Sustainability; Symbiotic partnership; World Engine**

3651

TROPISM^{1) - 2)}

The **adaptive growth** or movement **response** of an **organism** toward or away of some **stimulus**.

This classical definition acquires new shades of **meaning** through the systemic viewpoint.

Tropism is not purely reactive and indistinct. D. Mc NEIL, for instance, writes: "A tree is a heliotrope and an hydrotrope, a **structure** and a **process** of substance and **organization**" (1993 b. p.8).

In systems, a tropism becomes more or less governed by the systems general **controls**: The tree reacts in an adaptive and variable way to sunshine and to soil moisture by regulating "global **flows** and counterflows" (ibid).

3652

TROPOS¹⁾⁵⁾

A greek word whose meaning is orientation, direction. The same general **meaning** appears in "**entropy**" and "**tropism**"

It has been introduced by the Greek psychiatrist and systemist N. PARITSIS in his study of **psychological contexts** (2000)

3653

TRUTH: (no definition given, of course... and quote marks "...." should be used)³⁾

According to general scientific common sense, truth is supposed to exist and to be attainable by the human **mind** in a kind of asymptotic way, through progressive refinement of **experience** and thought, including insight and **intuition**.

C.S. PEIRCE defined "truth" as "the opinion that would be agreed if scientific inquiry were to continue long enough, the opinion that can withstand all possible experiential evidence and full logical scrutiny".

This is quite similar to K. POPPER's later view on **knowledge** progress through "falsification", i.e. refutation of existing views after new experimentation.

Or, in logic, "truth is an **isomorphism** between **objects** and **symbols**" (G. HUNTER, as quoted by F. FRISCHKNECHT and J.van GIGCH, 1989, p.243).

However, in its classical meanings, **truth** presents a difficult, and probably unsolvable **ontological** question, because of our indirect **perception** of reality through a sensory equipment that filters it in a selective way.

In a quite more restricted and realistic vein, J.van GIGCH writes: "We conveniently sidestep the problem of defining what is meant by "truth" by saying that... solutions obtained from **problem-solving methodologies** shall be labelled "truths". Also to be valid, "truths" should:

"1. Meet the **objectives** of those who framed the problem,

"2. Meet **criteria** of internal **coherence**,

"3. Correspond as far as possible with perceived external reality,

"4. Be accepted by its recipients, and,

"5. Be morally justified" (1983, p.44).

van GIGCH himself however admits that: "The **issue** of what constitutes a "morally acceptable" solution is not treated here, but pertains to the broader question concerned with the Morality of Systems" (ibid).

Moreover, point 1 could lead to a kind of pseudo-**ontological** expediency.

Point 3 correctly denotes the **observer's** problem, while point 4, implies that "truth" is a matter of **consensus**, and thus at the same time, specific to some group, eventually modifiable and easily shifting (I.I. MITROFF & H.A. LINSTONE, 1993, p.24).

More generally, "truth" depends as stated by van GIGCH, from the **paradigm** in force and offers always cultural overtones.

Truth anyhow implies **coherence**, as it should be non-contradictory in itself, and in relation to the experimental **field**. This leads to the **constructivist** viewpoint according to which truth is progressively constructed by **observers**.

From a more Popperian viewpoint, and in J. MINGERS words: "The **process** of disclosure is never ending and, therefore, truth is not an achievable end-**state**, or correspondence of theory to the world, but a horizon never reached, a never-ending **process**" (1992, p.175).

Some consider truth as the complete reception of all existing world views.

Of course, such a view of truth is totally social and remains scattered among all individuals simultaneously.

This make it impossible to "pin it down" in a unified way because the global **synthesis** can never be constructed, nor in a static, neither in a dynamic form.

Moreover, contradictions or psycho-**semantic** incoherences between different views (for ex. between the mathematical view and the idealistic or religious one) makes any compositional view of truth totally unpractical.

→ "**Ontological agnosticism**".

3654

TUNNEL VISION¹⁾³⁾

A **metaphor** sometimes used to characterize the very restricted views of any specialist who is unable to take in account what does not enter in his disciplinary **frame of reference**.

Originally tunnel vision is an eye-sight pathology corresponding to a restricted **field of visual perception**.

In order to avoid tunnel-vision thinking, three different degrees of meta-disciplinary understanding can be defined, starting with **cross-disciplinarity**, further broadened through **multidisciplinarity** and at best **transdisciplinarity**.

Cybernetic and systemic **concepts** and **models** are essentially transdisciplinary. High-level **management** of **complex issues** should integrate multiple specialized aspects into transdisciplinary vision, as a way to obtain a sound and strong **coherence** in **decision making** and **action** and avoid unsuspected **perturbations** and contradictions.

→ **Blindspots, Clanthink, Environment, Observer, Perception, Underconceptualization**

3655

TURBULENCE^{2) - 4)}

The irregular motion of a fluid with local randomly fluctuating velocities and pressures.

D. RUELE (1991, p.70) explains that turbulence appears in fluids to which a **source** provides *growing quantities of energy*. In that case, according to L.D. LANDAU, a growing number of flowing **modes** in the fluid become excited. Turbulence than results of the **neighborhood** of stable and unstable **regions**". Turbulence was more recently described by F. TAKENS and D. RUELE as a **chaotic process** that could appear even in a **dynamic system** with no more than three independent **frequencies**.

I. SINAI states that, in turbulence: "... the movement is so complex that the notion of individual **trajectory** loses its sense and the only possible **description** is in terms of average characteristics". He moreover connects turbulence with **ergodicity**: "(in) **ergodic theory**, the fundamental problem is the analysis of the causes generating the emergence of statistical laws in **dynamic systems**" (1988, p.69).

At a **limit**, the movement even escapes from **ergodic** regularity and turbulence also becomes connected with the study of **chaos** and **chaotic systems**. K.DE GREENE states: "In systems **evolution chaos** and turbulence may well be prerequisite to **structural change**... **Short-term** turbulence can be part of **long-term evolution** toward a new **structure**".

DE GREENE applies his views to "societal or ecological **transition** or **transformation** (when) **perturbation** of the **environment** by human actions may lead to the development of new pockets of **order**, or new **autonomous systems**, in the **environment**" (1990, p.52-53).

All this is coincident with the **model** of **fractalization** of **vortexes** (vortexes within vortexes, within vortexes, etc...).

Turbulence can be intermittent. This happens as stated by M. FARGE: "... when the most active **regions** are not homogeneously distributed in **space** and **time**, but on the contrary appear as turbulent and violent "puffs". **Spatio-temporal** intermittence does lead to questioning the **homogeneity** and stationary hypothesis basic to the statistical theory of turbulence" (1992, p.239).

3656

TURING MACHINE²⁾

A **digital** machine with a supposedly unlimited **data storage** capacity, operating on one or more tapes each containing a numeral to produce a tape containing a numeral (After J. MYHILL, 1964, p.109).

D. RUELE describes the machine as follows: "(It) has a finite number of internal **states**: active **states** and a stop **state**. It does its work on an infinite ribbon, divided in a succession of squares (This ribbon serves as a **memory**). On each square on the ribbon a **symbol**, part of a finite **alphabet**, is written, one of these **symbols** being *void*. The TURING machine works by successive **cycles**, perfectly foreseeable. If it is in the stop position, it does nothing. Otherwise, the machine reads the square it occupies and, according to its internal **state** and to what it just read, will do one of the following:

- it will erase that which is written and write something else (Or the same thing) in the square;
- it moves to the next square, to the left or to the right;
- it changes to another internal **state**.

"If the new internal **state** is an active one, the machine will start a new **cycle**, according to the content of the new square and its new internal **state**."

"At the initial **state**, the ribbon contains a finite **message**, the **data message** (the rest of the ribbon is empty, i.e. made of squares marked with the *void symbol*). The machine starts at the beginning of the **data message** and... when it stops, it has written a new **message**, its answer or results **message**. The answer can be yes, or no, or possibly a number, or a longer **message**. It is possible to arrange a TURING machine to add or multiply whole numbers, or any other task that could be carried out by a computer".

In other words, the TURING machine is the universal theoretical model of the computer, in which an **algorithm** is used to process **data**, nothing more being needed.

RUELE adds: "There is no need for an infinity of different machines for different tasks, because there exists a *universal* TURING machine. To operate a specific **algorithm** on this universal machine, one must describe on the ribbon a **data message** that contains at the same time the **algorithm's description** and the specific **data** that should be processed" (1991, p.181-2).

G. KLIR states that, according to the CHURCH-TURING thesis: "... a TURING machine is taken to be a precise formal equivalent of the intuitive notion of an **algorithm**" (G. KLIR, 1991, p.128).

As may be observed, these elements correspond to the computer **program** and the **data store**.

The unlimited **storage** capacity, which for example "would be required to multiply two arbitrary large numbers" (Ibid) is however a practical impossibility.

M. BUNGE rightly observes: "... TURING machines..., being equipped with infinitely long tapes, are strictly speaking unrealizable" (1977, p.33). They are a kind of thought experiment... which however led to the whole of computer technique.

E. VACCARI and M. D'AMATO put it in a different way, but the meaning is more or less similar: "In a dynamic perspective, the Turing machine might be considered as a special limiting case of a discrete **time/discrete space model**, where the time between **state changes** is of no significance"(2000, p. 175)

3657

TURING STRUCTURES^{1) - 2)}

Emergent **heterogeneous structures** in a **homogenous distribution** of chemicals.

In his 1952 paper on "The chemical basis of **morphogenesis**", A. TURING showed that some chemicals, **homogeneously** distributed at first, may, by **reactions** and **diffusion**, lead to variations in their local concentrations, i.e. to **heterogeneity**, and form spatial **structures**.

This has been experimentally verified. As an **asymmetry** creating mechanism (rediscovered in 1976 by H. KUHN), it has a very general explanation power for the **morphogenesis** of **complex systems**, based on simple **evolution rules**.

As a result, similar **dynamic behavior** or **structures** may be found in very different systems, as for example in vegetal helixes (S. DOUADY and Y. COUDER, 1993).

3658

TURING's TEST^{1) - 3)}

The English mathematician A. TURING proposed a test to find out if a given **machine** can be considered intelligent (1950).

As a synthesis, in the words of P. DENNING: the test is "... an imitation game in which an interrogator asks questions of a human being and a **machine**; if the interrogator is unable to distinguish between the two, the **machine** passes the test and is declared intelligent. TURING replaced the question "Can a machine think?" (Title however of his quite more exhaustive 1950 essay - see 1956) with "Can the interrogator distinguish the two in an imitation game ?" because he considered the former question so imprecise as to be meaningless. His own opinion was that by the year 2000 there would exist **machines** capable of fooling the interrogator for at least five minutes in 30 % of the games played" (1990, p.100).

J. WEIZENBAUM's ironic book about his ELIZA program for psychological study, shows that the very acumen of the interrogator should also be tested in order to validate the test (1976).

At the time TURING devised his test, only sequential computers were in existence, and their potential **performances** were abysmally low, compared with the present ones. However, the **algorithmic** character of sequential computers **programs** still seems to rule out intelligence for this class of **machines**, even in chess playing or **expert systems**. However, the new **connection machines** and neural type **networks**, which are able to learn could easily reactualize TURING's test in a new way.

3659

TURNOVER¹⁾

The **process** by which the **elements** of a system are continually replaced by new ones of the same kind.

Such a replacement is a general feature of **living systems** and is operated through **self-catalysis** or **hypercycles**.

On the contrary, there is no turnover in **artefacts**.

3660

TURNOVER TIME¹⁾

The time needed for the total replacement of some **class** of **elements** or some stored **resource** in a system.

The turnover time depends on the internal **cycle** of **input** and **output**, correctly synchronized with the **level** of availability of the corresponding prime **resource** in the **environment**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

A well-regulated turnover time is necessary to maintain **dynamic stability**.

3661

TWO-BODIES PROBLEM²⁾

The two-bodies problem is the characteristic one of classical mechanics. It concerns the **deterministic interaction** of two bodies (in the celestial mechanics sense, for instance) reciprocally related through a simple **causal interdependence**. Such a problem is easily solved through a **differential equation** which states how certain quantities *and their rates of change* are related.

This kind of solution is however based on an implicate postulate, i.e. that such **relations** are not significantly perturbed by other "bodies". This is the famous lemma "...et ceteris paribus", which is generally invalid in the case of **complex systems**, even if and when **perturbations** are slight, some approximate solution may be found.

H. POINCARÉ was first to understand the nature of these difficulties as early as 1892, in his study on the **three-bodies problem**

3662

TYPES (Theory of logical)

→ **Logical types (Theory of)**

Table: see entry **Typology of Organizationally-Closed (Self-Referential) Systems**

3663

TYPOLGY OF ORGANIZATIONALLY-CLOSED (SELF-REFERENTIAL) SYSTEMS

John MINGERS proposed the following classification of organizationally-closed systems, all them being at least self referential (1999)

see table below

U

3664

UBIQUITY (Conceptual)¹⁾²⁾³⁾

The very general validity attributed to some **concepts and models**.

This new **meaning** for the term "ubiquity" has been proposed by M. BUCHANAN in a recent book (2000). He thus described the application of some concepts and models to a very wide variety of **situations or processes**.

He gives as an example the **self-organized criticality model**. This model has been used in many types of situations where a system is on the brink of some considerable sudden **change** or catastrophic **crisis**.

Examples are:

- the **distribution** of forest fires in Australia and the U.S.
- the distribution of measles **epidemics** on the Faroe Island in the North Atlantic

- the unstable situation in Europe in 1914 and the assassination of Arch. Franz Ferdinand of Habsburg which triggered World War I (Per BAK, 2000, p. 56-57)

Self organized criticality is only one of the new models of systemic character that appeared during the second half of the 20th C. in the course of a deep change of the basic **paradigm** about what scientific research does, and what is meant by "**explanation**"

It should be noted that in former centuries other concepts or models have also been ubiquitous, as for example **mechanistic determinism** in the 19th C. and first half of the 20th C..

Moreover, old concepts and models are not necessarily abandoned, but only reconsidered and put in a different perspective when new ones are introduced.

→ **Catastrophe theory; Chaos; Cycle; Cyclogenesis; Discontinuity; Powerlaws; Stability (Dynamic)**

3665

ULTRASTABILITY^{1) - 2)}

"The form of **stability** apparent in an **adaptive system**" (G. PASK, 1961a, p.115).

Adaptive systems possess **controllers** which are themselves adaptive, i.e. able to counteract a wide **variety** of **environmental** or **invironmental perturbations**.

Level in Boulding's Hierarchy	Relations that Characterise Level	Type	Characteristic	Example
1 Structures	Topology (Spatial)	<i>Self-referring systems</i>	Structural reference to self by position or symbolism (pictorial or linguistic)	"This is a sentence", Escher's "Drawing Hands", Magritte's "The Treason of Images"
2 Mechanisms	Order (Dynamic)	<i>Self-influencing systems</i>	Dynamic systems that involve circular causality and causal loops	Size and birth rate of population, inflation, the nuclear arms race
3 Cybernetic systems	Specification (Feedback)	<i>Self-regulating systems</i>	Maintenance of a particular variable at a particular level	Thermostat, body temperature
		<i>Self-sustaining systems</i>	All parts of the System are necessary and sufficient for operation of the whole, but do not produce each other	Gas pilot light in heating boiler, autocatalysis, nervous system
4 Living systems	Autopoietic relations	<i>Self-producing systems (autopoietic)</i>	Autonomy, the system both produces and is produced by itself	Cell, computer model of autopoiesis,
5 Multicellular systems	Structural coupling between parts	<i>Self-recognising Systems</i>	Systems that are able to recognise their own parts and reject others	Immune system within an organism
		<i>Self-replicating systems</i>	Systems that can build replicas of themselves	Organisms that reproduce, computer viruses
6 Nervous systems	Symbolic / Abstract relations	<i>Self-cognising systems</i>	Systems that generate cognitive identity through recursive neuronal activity	Animals with nervous systems. interacting symbolically
7 Observing systems	Self-Observational relations	<i>Self-conscious systems</i>	Able to interact with descriptions of themselves. The observer observing the observer	A person saying "I acted selfishly today"

From John Mingers – "Cybernetics and Human Knowing" – Vol 6(4) 1999

Ultrastable systems are able – up to a point – to change their internal **functional organization** and **structures** in order to adapt to external **disturbances**. However such changes must respect **global coherence**: “If the **whole** is at a **state of equilibrium**, each part must be in a **state of equilibrium** in the conditions provided by the others” (W.R. ASHBY, p.82).

And: “No **state** (of the **whole**) can be a **state of equilibrium** unless it is acceptable to every one of the **component parts**, each acting in the conditions given by the others” (p.83).

Ultrastability is thus the **oscillating** stability of the set of **critical** interconnected **variables** in a system, obtained through their repeated reciprocal **action**.

To demonstrate these characteristics, ASHBY constructed his well known “**Homeostat**”, an experimental cybernetic **machine** which shows an enormous **variability** potential, through **oscillations**... but tends to oscillating **stability** within **limits**.

In a **concrete system**, ultrastability requires **self-regulation** and therefore it must contain a good model of itself.

3666

ULTRAVARIABILITY ^{1) – 2)}

“The repeated and qualitatively heightened capacity for **change**” (V. KREMYANSKIY, 1969, p.132).

As he refers himself to **ultrastability** and **variability** as they have been studied by ASHBY, KREMYANSKIY writes: “It is known that the latter serves as a means for attaining **stability** (stabilizing **variability**); but, in addition (and this is far more important in biological systems), it serves as a means for developing new **forms** both of the species’ **stability** and also of the **variability** itself (**form-creating variability**). It is easily shown that an increased number of **components** (...) increases **variability** and has several other advantages” (Ibid).

The concept of ultravariability evokes also the swift and deep upheavals in **evolution**, to which S.J. GOULD and N. ELDREDGE give the name of punctuated **evolution**. The “increased number of **components**” could also be paralleled with the shaping of **dissipative structures** in systems submitted to **giant fluctuations**, **phenomenon** that may lead to the **emergence** of systems of a new type.

Ultravariability relates obviously to **phenomena** very different than those considered by the concepts of **autopoiesis** and **organizational closure**.

3667

UMWELT LEHRE ^{1) – 4)}

The specific **knowledge** any **living system** acquires about its **ambient** or **environment** (Umwelt, in German).

“Umwelt Lehre” leads to specific “**window perception**”, different for each **living system**.

This concept was introduced by J.von UEXKÜLL (see 1979). According to L.von BERTALANFFY: “It essentially amounts to the statement that, from the great cake of reality, every living **organism** cuts a slice, which it can perceive and to which it can react owing to its psycho-physical **organization**, that is the **structure of receptor and effector organs**” (1962, p. 73).

As stated by BERTALANFFY, von UEXKÜLL and KRISZAT have presented fascinating pictures how the same section of nature may look as seen by various animals. (see 1934)

“According to von UEXKÜLL’s expression, any **organism**, so to speak, cuts out from the multiplicity of surrounding **objects** a small number of characteristics to which it reacts and whose ensemble forms its “**ambient**” (Umwelt). All the rest is non-existent for that particular **organism**” (1962, p.73).

This Umwelt concept may seemingly be applied also to social systems, wherein a consensual psycho-mental Umwelt becomes absolutely dominant, and blinds the members of the group to anything else.

3668

UNBOUNDED SYSTEMS THINKING (UST) ^{1) – 4)}

An **Inquiry System** in which “everything interacts with everything” (I.I. MITROFF and H.A. LINSTONE, 1993, p.91).

In UST “all branches of **inquiry** depend fundamentally on one another, and... the widest possible array of disciplines, professions, and branches of **knowledge** – capturing distinctly different **paradigms** of thought – must be consciously brought to bear on our **problems**.

“In UST, the traditional **hierarchical** ordering of the sciences and the professions – as well as the pejorative bifurcation of the sciences into “**hard**” versus “**soft**” is replaced by a circular **concept of relationship** between them. In UST, everyone of the sciences and professions is considered fundamental; none is superior to or better than any other” (p.91).

UST introduces a **Multiple Perspective Method** (see corresponding heading), characterized by a triple perspective:

“T. The Technical Perspective
O. The Organizational or Societal Perspective
P. The Personal or Individual Perspective” (p.99).

The authors insist on the following aspects in using the **method**:

- “- Strive for a balance among T, O and P perspectives
- Use “good” judgment in selecting perspectives
- In obtaining **information**, recognize that O and P require greatly different **methods** than T

- Pay particular attention to the mutual impact, **interdependencies**, and **integration** of perspectives
- Beware of thinking statically in **dynamic environments**” (p.107-8).

And “UST is fundamentally a **transdisciplinary Inquiry System**. That is, UST does not believe that we can “solve” important problems within the current **structure** of the disciplines, professions, or the modern university. The various sciences and professions are the product of human **organization**. In this sense they are **artifacts**, not natural entities. As such, in working on every **problem**, we are also simultaneously working on how we organize ourselves to solve our **problems**” (p.109).

UST is yet one more example of the new focus on a **transdisciplinary** approach in order to avoid what WARFIELD call **underconceptualization** and de ZEEUW, **invisibility**.

3669

UNCERTAINTY ^{1) – 3)}

The impossibility to reach a perfect **knowledge** of any **complex system** or **situation**.

The uncertainty problem came slowly to pervade the whole field of **complexity**. This is normal, considering that the multiplicity of **initial conditions** in **complex systems** leads to **chaos** and a high degree of **unpredictability**.

It offers different facets, related for ex. to the interrelations between **levels of complexity** and the various limitations to **perception** and construction of mental **frames of references**.

The problem is also associated with the general conditions of **modeling**, as shown by G. KLIR, within the frame of his **reconstructibility analysis**. (1991, p.350; 399-401)

E. MORIN distinguishes four different shades of uncertainty

1. Brain-mental uncertainty, which results of the **process of perception**, and **modelization of “reality”** by the **brain**
2. Logical uncertainty according to which some **ambiguity**, **complementarity** or even contradiction seems to be inherent to our **reconstruction of reality**. BOHR’s and the Copenhagen interpretation in micro-physics is an example
3. Rational uncertainty due to the **fuzzy** border between rational **explanation** and fake or uncritical rationalizations
4. Psychological uncertainty due to our necessarily limited **awareness** of the soundness of our own mental **processes** (E. MORIN, 1999b, p. 82-84)

3670

UNCERTAINTY (Chaotic) ^{1) – 2) – 3)}

P. COVENEY, in accordance with Prigoginian thermodynamics of **systems far-from-equilibrium**, alludes to “... a new kind of uncertainty principle that applies to chaotic dynamical sys-

tems. This new principle shows that complete certainty of the **thermodynamic** properties of a system (through **knowledge** of its irreversible age) renders the reversible dynamical description meaningless, whilst complete certainty in the dynamical description similarly disables the **thermodynamic view**" (1990, p.52).

Would chaotic uncertainty not be an obliged result of **chaotic determinism**, which maintains a global **determinism**, but does not allow any more a precise **predictability**?

3671

UNCERTAINTY (in psychological sense)^{3) - 4)}

Any **interaction** between an **observer** and what is observed, changes both.

D. Mac KAY writes: "The second type of "absolute" uncertainty attends our **knowledge** of one another in interpersonal **dialogue** (as distinct from detached physical **observation**. Quite independently of any physical **indeterminacy** of our **brain** mechanism, this uncertainty reflects the fact that, in the public calculus of two or more persons in **dialogue**, *no valid definitive prediction exists* for their detailed future **behavior**. In this **relationship** the action of each has an irreducible (potential) selective **information-content**, for his fellows as well as for himself" (1969, p.154).

Here again, like in the case of **indeterminacy**, it is arguable if every individual (and every group) can ever act outside the global **determinism**, as the product of education and instruction within a specific culture, not to speak of the general human conditionings.

3672

UNCERTAINTY (Measure of)²⁾

"The average number of **binary decisions** a decision maker has to make in order to select one out of a set of actually exclusive alternatives" (K. KRIPPENDORFF, 1986, p.77).

This number is the logarithm of the number of possible alternatives.

According to G. PASK: "Given a well-defined **set of elements**, it is possible to measure the *amount* of uncertainty with reference to this **set**. The **reference frame** provides a **set of states**, hence a measure of uncertainty is possible and is called the *variety* of the **set**. ... **Information** and uncertainty, if expressed in an additive form as logarithmic measures, are very simply related indeed:

Uncertainty = - Information" (1961, p.26).

This is, of course, the quantitative aspect of uncertainty, based on the hypothes of a **consensus** on their **data** among the different **observers**. PASK himself has been quite concerned by this **consensus** problem.

3673

UNCERTAINTY PRINCIPLE^{2) - 3)}

"It is impossible to simultaneously measure the position and the momentum of atomic particles with an arbitrary degree of accuracy".

K. KRIPPENDORFF writes: "The principle recognizes the fact that, on the atomic **level**, any **measuring process** involves **energy** which by necessity interferes with the **energy** measured" (1986, p.78). This is because both energetic actions are at more or less the same **level** of intensity.

It would be advisable to better distinguish **indeterminacy** from uncertainty.

The first word relates more closely to any **situation** in which it is impossible to know exactly and simultaneously two (or more) characteristics of an observed **object**, especially in the realm of micro-physics.

Trying to better the instruments of **observation** is practically useless, as noted by H.H. PATTEE: "... the more you describe the measuring device, the less effectively it measures or describes the system" (1977, p.262).

On the other hand, HEISENBERG himself speaks also of an "Uncertainty Principle" (not merely **indeterminacy**), which introduces obviously an epistemological problem. J.C. TABARY states: "No **information** about Nature "in itself" can reach us, but merely **informations** on our own deformation when in contact with Nature: Nature's image becomes the image of our physical relation with Nature" (1989, p.278).

3674

UNCERTAINTY SET^{2) - 4)}

The **range** of expected future **disturbances** that may affect a system.

This notion has been enunciated by M. MESAROVIC et al in a study about the satisfaction conditions in biological systems (1973, p.68).

It could also probably be introduced in economic and social systems and in industrial and business enterprises.

The definition of an uncertainty set is necessary for an optimum calibration of the **regulators**. It remains however always somewhat conjectural.

3675

UNCOMPUTABILITY THEOREM²⁾

"Given a **program P** and an **input data set I** there is no way in general to say if P will ever finish processing the **data I**".

This theorem was enounced in 1936 by A. TURING and is closely related to the **incompleteness theorem** of GÖDEL.

It relates also to what is known as the **halting problem**, thus formulated by J. CASTI: "Is there a *general algorithm* for determining if a program will halt ?" (1990, p.346).

While the problem has some partial and specific solutions, TURING demonstrated that no general one does exist.

As observed by A. CHURCH, uncomputability reflects **undecidability** and non-**recursivity**.

3676

UNCORRELATED EXTREMES (Law of)^{2) - 4)}

"No matter what the complex **issue**, and no matter what the **group** involved in its study, the *initial* aggregate **group** opinion concerning the logical **pattern** of the factors involved in the **issue** and the *final* aggregate **group** opinion concerning the logical **pattern** of the factors involved in the **issue** (i.e. the views at the two extremes...) will be uncorrelated; showing that significant **learning** takes place through the application of the **Generic Design process**" (J.N. WARFIELD, 1995, p.145).

The law is evident for anyone who has once participated to a **group** discussion. The point is that its practical consequences (the "**Babel tower effect**") are generally not perceived, and still less taken care of.

Still more important is that WARFIELD's **methodology** of **Interpretive Structural Modeling** through **Nominal Group Technique** permits the discovery of the whole field of opinions, as well as their relative weights. It thus opens the way to a thorough evaluation by the **group** of the whole **range** of opinions, avoiding resentment from those who otherwise should not have been given a voice. In this way, a base for real **consensus** can be constructed.

3677

UNDECIDABILITY^{1) - 3)}

An ambiguous **situation** in which it is not possible to decide the **truth** of a proposition or to take a definite stand in a **decision process**.

J.van GIGCH writes: "Undecidability existing at one **level** of **language** can only be removed by the use of a **metalanguage**" (1990, p.128).

This is clearly a generalized consequence of GÖDEL's **Incompleteness theorem**, and is also reflected in A. CHURCH thesis according to which "decidability is equivalent to **recursiveness**, which is equivalent to computability" (as quoted by R. SCHOENFELD, 1949, p.88).

3678

UNDERCONCEPTUALIZATION^{3) - 4)}

The insufficient **understanding** of complex **issues** by any single individual or **group**.

J. WARFIELD, who introduces this concept distinguishes three different aspects of under-conceptualization:

"1. Structural underconceptualization means that the **organization** of the **information** about a given issue is insufficient to enable the important **patterns** to be inspected... We can say... that ordinary **processes** omit recognition and interpretation of the **cycles** that are at work in a given **issue**...

"2. The second aspect... stems from the normal absence of any sense of length of logic (note: i.e. interconnected logical sequences)

"3. The third aspect arises by ignoring in ordinary approaches to **issues** the human limitations on working mentally with **information**, which are well known from the work of MILLER, SIMON, and others, but which seem systematically to be ignored in **systems analysis** and **design activity**" (1991, p.200).

3679

UNDERCONCEPTUALIZATION (Law of structural)^{1) - 2) - 3) - 4)}

"No matter what the complex **issue**, and no matter what the **group** involved in its study, the outcomes of ordinary **group process** (i.e. the **process** in which computer support for developing the formal logical **structure** of the issue is lacking) will be structurally underconceptualized (as evident, for example, by the lack of delineation of the **cycles** and of any **structural connections** among them)".

The law merely states the foregoing WARFIELD's explanations about underconceptualization.

3680

UNDERCONNECTANCE^{1) - 2) - 4)}

A characteristic of "a system which is very susceptible to intrusion since there are insufficient **connections** between the **parts** for the system to maintain integrity" (T.F.H. ALLEN & T.B. STARR, 1982, p.280).

This definition seems to apply nicely to overextended systems.

An obvious application can be made to ancient empires whose overextended **communication** lines combined with the resulting **time lags** in the **transmission** of **information** tended to push them toward their disintegration, mainly through the intrusion of alien groups and the **emergence** of local powers.

3681

UNDERCROWDING²⁾⁴⁾

The situation where an insufficient **density** of **population** undermines social **stability** and even possibly **survival**

A minimum number of individuals in a given **environment** seems to be necessary for triggering **social behavior**. In a recent paper A. BARNET notes for example that "flamingos or

penguins won't breed unless they are surrounded by other copulating pairs"(2001, p. 38) Undercrowding seems to induce the following negative **effects** on societies:

- possible loss of genetic and behavioral **variety** (In societies, also loss of **cultural** and **semantic** variety)
- loss of **herd** protection effects
- lessening of transgenerational **learning**
- lack of **communication** and loss of **information**
- danger of destructive episodes due to reduced **adaptability** (the Fuegians extinguished by a succession of negative factors as epidemics, alcoholism, etc)

A comparison with the **situation** of **overcrowding** shows that any **population** must remain in a defined **dynamic stability** relation with its probably variable **environment**. Such stability corresponds to also defined **levels** of maximum and minimum **density**, within a sustainable **range of fluctuations**

Undercrowding effects were first studied by W. ALLEE in the U.S.(1951) and are now known as "Allee effects"

3682

UNDERLOAD STRESS^{1) - 2)}

Stress induced in a system by insufficient **inputs** of **energy**, **matter** and/or **information**.

N. PARITSIS comments: "If the **environment** is too simple and remains unchanged, the **organism** has very little to learn, meaning that simple **environments** also inhibit **learning** and are producing underload stress" (1992, p.38).

For comparison, see "Overload".

3683

UNDERSTANDING³⁾

The ability to interrelate **informations** within more general embracing mental **frames of reference**.

Understanding leads to the creation of **knowledge**, which consists of systems of coordinated **informations**, which can be put to use in the following ways:

- obtain working interpretations of the **significance** of interconnected **informations**.
- discuss the **validity** of such interpretations.
- correct and expand already existing **frames of reference**.
- Use **knowledge** obtained in this way to seek workable alternatives on issues, to - further better **design** of projects and to make **decisions** based on well informed - **choices**.

There is a specific form of systemic understanding which corresponds to the use of **frames of references** allowing interpretations of **nonlinear systems**.

In relation to **conversation** and **consensus** and according to H.von FOERSTER we can only "construct our own understanding of the other's understanding" (1993, p.110)

We should thus have to rely on the other's agreement on what we express about our understanding of him/her... and reciprocally. This is indeed a shaky ground for reciprocal understanding and consensus... but it is the only one we have!

In a quite different vein, R. GLANVILLE also explores what we do mean by "understanding". He writes: "We are different: I can never have your understanding of your understanding, which is precisely not your understanding)" (2001, p. 145-46).

The meaning of "conversation" in Pask's sense is the reciprocal polishing of our respective understanding. Nobody can better understand anybody else without a conversation in which each one testifies how he/she understands the other's understanding.

The typical dialogue would be:

"-If I understand you well, you mean that..."

"-Well, more or less if interpreted in your terms. But what do you mean when you say that my opinion is that...?"

Of course that type of dialogue can easily become a hopeless **semantic** and mental circular labyrinth. This can be avoided only between good-willed people in search of sincere and useful reciprocal **communication** through progressive mutual spiraling **adjustment**.

It is however a very good cure to intolerance, fanaticism and even simple stupidity

In a still more subtle way, understanding refers to the general **implicit meaning** of what we are perceiving and cannot (or cannot yet), or do not want to express as knowledge in a specific **language**.

In KRISHNAMURTI's words : " In the interval between words, between thoughts, comes understanding and...this interval is silence unbroken by knowledge"

3684

UNEXPECTEDNESS as a measure of negentropy^{2) - 3)}

Mac KAY defines unexpectedness as "the average logarithm of the improbability of a **message**:

$-\sum p_i \log p_i$ " (1969, p.57).

As unexpectedness is a measure of improbability, it is the contrary of high probability, which is closely related to nearly homogenized systems after a considerable and not compensated production of **entropy**.

It may thus be considered as a measure of **negentropy** in systems wherein the production of **entropy** has been coupled with **structuring dissipation** to lead them towards the **emergence** of higher **complexity**, i.e., **heterogeneity**.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3685

UNFOLDMENT¹⁾

The gradual **development** of a system's internal **order**.

In **complex systems**, since their very genesis, there is an implicit (or in D. BOHM's terminology "implicate") **order**, which becomes revealed as the system grows. Viewed from this approach, as stated by F. DAVID PEAT: "The universe is sustained through an act of creative unfoldment in which no **order** is absolutely fixed, but is able to respond to an ever-changing **context**" (1987, p.215).

This is a very general property of biological, social or conceptual systems. An interesting example is the development of a musical fugue.

Unfoldment is a possibility implicit in **organizational closure**.

However, unfoldment is never total, since it depends on the external **constraints** that the system will meet during its **development**.

3686

UNIDIRECTIONALISM¹⁾²⁾

A basically **top-down communication process**.

Any process wherein the receiver of the **message** is not able to give any **feedback** to the emitter is unidirectional and tends to have **conditioning effects**.

This applies for ex. to any type of cathedratic teaching, to written, broadcasted or television **information**, and also to computer transmitted **information** when the receiver is not supposed to discuss or elaborate on what is mailed to her/him.

It may be useful to a point in teaching, but it is frequently a tricky and objectionable **process** as when used for propaganda and even in many cases to publicity

→ **Multidirectionalism**

3687

UNIFICATION PROBLEM²⁾³⁾

The unification problem emerges from our general (cartesian) **methodology** to fragment **complex systems** in severed **parts** in order to better understand their nature.

However such "cutting to pieces" destroys, or at least, reduces our understanding of the **whole** system.

L. LÖFGREN (2000, p. 15-20) sees the problem mainly as a result of our **languages**, which is clearly true, at least in western cultures

He sees any low **fragmentation** as unavoidable and even proposes it as a fundamental concept for General Systems. He offers as "a first natural proposal...an *interdisciplinary* understanding"(p. 15). This may seem insufficient in order to restore an integrated holistic view, as it most generally amounts merely to a "collage".

This editor believes that we should reach for *transdisciplinarity*, i.e. creating a language of systemic **concepts** and **models**, mainly for the purpose of **wholeness understanding** through the study of **links** and **relationships**.

→ **Linguistic closure**

3688

UNION EUROPEENNE DE SYSTEMIQUE¹⁾

The Systems Science European Union (UES) started in 1989. It is an European association of national systems science societies, including at date, the Czech, English, French, Greek, Italian and Spanish Systems Science societies. The Union is open to all European national societies. Main goals are: promotion of the systems sciences and coordination of activities within an European plan: schools, meetings, debates, teaching and the publication of the Revue Européenne de Systémique: res-systemica available at: www.res-systemica.org

3689

UNION OF INTERNATIONAL ASSOCIATIONS¹⁾

This Union was created in Brussels before the first World War. It became very active from the 1970's on under the impulse of his General Secretary A. JUDGE, who publishes and updates a very useful Encyclopedia under the title: "World Problems and Human Potential" (Saur Verlag, München)

3690

UNIT (Behavioral)²⁾

A **population of elements** ("behavioral atoms" in J. HOLLAND's terminology) in an **adaptive system** "which generates **action** sequences, and is modified on the basis of the outcome" (1992, p.155).

The behavioral unit is the very basic adaptive device in the system. Its **behavior** depends on its reactions to registered **environmental effects**. However these reactions depend also on the internal **behavioral rules** of the system.

HOLLAND's behavioral units seem to be indispensable for **parallel distributed processing**, as described by Mc CLELLAND et al., (1986)

3691

UNIVERSAL PROPERTY²⁾

"A property that does not change under a re-normalized **group transformation**" (G. MAYER-KRESS, 1988, p.357).

The author states: "... the base idea is to determine how a given system behaves under a **transformation** which changes the **scale** and also perform a **symmetry** operation (Ibid).

He proposes the interesting idea of an inverse reconstruction of the Cantor segment, starting from the "dust" of points obtained in the Cantor set after **fractalization**. In this way "more and more of the gap are covered with solid intervals... (and finally) we arrive at only one single segment interval" (Ibid).

In this way a complex **whole** is constructed by the sole use of one specific, well defined iterative **transformation**. This could be done also, for example, with the **WEIERSTRASS function** and lead to the idea that **complexity** may result from the **scaling, level by level**, of some very simple **rule** or **rules of transformation**.

→ **Game of life; Reconstructability analysis; Stigmergy**

3692

UNIVERSE^{1) - 3)}

The totality of which an **observer** is aware of.

J. L. DESTOUCHES writes: "Any system is a **whole** always contained in another **whole** called "Universe" or **environment**" (1947, p.196).

Of course, the "universe" selected by the **observer** at one moment is less than the total universe that he/she could observe, and this in turn is less than the total existing universe.

Any **observer** has "**blindspots**". Nobody is capable to observe more than a very small **part** of reality, of which many aspects remain hidden to any of us.

A very important aspect of systemic training is covering the need to understand our perceptive and conceptual **boundaries** and to know the permanent "**invisibility**" (G.de ZEEUW) for us of many features within the real world.

As emphasized by the French economist J. FOURASTIÉ, there is something worse than ignorance and it is ignorance of our ignorance.

3693

UNIVERSE, from LAPLACE to chaos³⁾

The French mathematician and astronomer P.de LAPLACE proposed a "clockwork" **model** of the universe through the hypothesis according to which "one who should know the positions and movements of all the bodies of the universe at one instant, would be able to predict their positions at any moment of the future". This view seemed indeed strongly confirmed by some spectacular astronomical discoveries during the 19th century based on this type of deterministic calculus.

However, POINCARÉ showed in 1889 that some quite simple astronomical problems (the famous **three bodies problem**) could not be rigorously solved.

This was the starting point of **chaos theory**. In P. DAVIES words: ... even one such **chaotic system** would rapidly exhaust the entire Universe's capacity to compute its **behavior**. It

seems then, that the Universe is incapable of digitally computing the future **behavior** of even a small **part** of itself, let alone all of itself. Expressed more dramatically, the Universe is its own fastest simulator" (1990). R. JENSEN expressed the same idea (see hereafter).

3694

UNIVERSE (Relational) ³⁾

This concept is introduced by M. MARUYAMA who writes: "In contrast to the classificational universe which is substance-oriented, the relational universe is **event-oriented**...

"Instead of the preoccupation with the ontological or causal priority among beings, in the relational universe, the mutuality of **interactions** predominate. "Definition" is not given by **categories** and subcategories, but by **interactions** and **interrelations**... This should not be misconstrued as "dialectic opposition". Its mode is **complementarity** and harmony, fusion rather than division...

"The **relations** are many-sided, mutual, situational, and not governed by the principle of subordination, superordination and paraordination. The relational universe does not establish **hierarchy**" (1966, p.57-58).

These views are closely related to the **deviation-amplifying models** of the same author.

3695

UNPREDICTABILITY ^{1) - 3)}

A total or relative impossibility to predict the future **behavior** of a **complex system**.

Most importantly, I. PRIGOGINE and I. STENGERS observe that "... the existence of **chaotic systems** transforms the notion of unpredictability, frees it from the idea of a contingent ignorance, that a better **knowledge** would surmount, and gives it an intrinsic **meaning**" (1992, p.81).

While singled out **processes** within a stable **environment** are generally **linear** or reducible to **linearity**, **complex systems** exhibit normally a **chaotic behavior**, which makes them more or less unpredictable, due to constant interferences between **processes** of different **periods** resulting for a multiplicity of simultaneous **initial conditions**.

R. JENSEN states: "Another manifestation of the unpredictability of **chaotic dynamical systems** is that the **time-evolution** is computationally irreducible... There is no faster way of finding out how a **chaotic system** will evolve than to watch its **evolution**. The dynamical system itself is its own fastest computer" (1987, p.179).

While this is true in theory, *imperfect* predictability is feasible: most systems have some characterized **dominant periods** which remain more or less observable, even if they are to some measure deformed and obscured by **chaotic** ripples brought about by various or even

numerous other **cycles** of lesser weight, as well as subject to sudden and massive **trend variations**. In short, some **patterns** remain more or less visible.

→ **Action (ecology of); Forecasts (limits to)**

3696

URBAN ECOSYSTEMS ⁴⁾

"Ecosystems with **components** mainly of urban built characteristics and with relatively high **densities** of human **populations**" (UNESCO – UNEP glossary, 1983, p.28).

The glossary comments: "It is recognized that urban ecosystems are not self-sustaining or complete ecosystems and are dependent on outside **sources** and factors" (Ibid).

3697

URBAN ENVIRONMENT ⁴⁾

"The resulting effects and **interrelationships** of human **population** concentration, the built **environment**, and the biophysical **environment**" (Ibid).

The UNESCO glossary observes that "city dwellers often view the urban built **environment** as the only "environment", and it consequently advocates "the need for environmental education to encompass the entire environment..., i.e. a **holistic** view of the complete environment" (Ibid).

3698

USEFULNESS ¹⁾

That which can **changes** a **situation** in an advantageous manner.

Such a definition is obviously ambiguous: what should be advantageous is a matter of **criteria**. Moreover, a wide **variety** of **criteria** could be considered: economical, social, technical, etc..., or personal, groupal or general.

In accordance with different **criteria**, **decision makers** may find it difficult to make a globally satisfactory **choice** between different useful, but sometimes irreconcilable options.

Finally usefulness in systemic terms should be judged according to the vantage to the system in general (global **optimization**, **long-term survival**), and the **maintenance** of its supporting **environment**. Such judgment can be reached only by an integrated systemic approach.

3699

USOMID

"The Slovene abbreviation for: Oriented, Wholistic, Co-operative and Organized Invention and Innovation Activity of the Masses" (M. MULEJ, 1986, p.151).

MULEJ describes as follows the ten components of the USOMID methodology:

"1. Education for creative **co-operation** with short courses ... and practical experience;

"2. Development of "being considered" as the basic value guiding people toward **creativity**, and so a precondition for their motivation for creative **co-operation**;

"3. Charting the **processes** which take place in the **organization**, in **co-operation** with the workers who do them and know most about them, including also the **processes** of creative work, in **framework programs**, compiled in a "programmotheque";

"4. Possibly, a computer-aided programmotheque, deeper in quantitative insights into the basic **process** (supply-production-marketing)

"5. the USOMID/SREDIM procedure as the method of creative **co-operation**;

"6. Deliberate seeking for possible **changes** as the basic orientation of such a creative **co-operation**;

"7. Application of **management by objectives** which include support and constant care for creative **co-operation** as a whole and its **strategies** for innovation with **objectives** of every (middle) manager and foreman:

"8. Proceeding from the general insight toward details in order to fight unavoidable one-sidedness by interlinking the specialists' **viewpoints** into a (dialectical) system of all essential viewpoints;

"9. Studying the **processes** and their **environment**, not the organizational **structure** and the **hierarchy** of subordination, and following the links of their steps with the "causes tree"

...

"10. The USOMID circle as the organizational possibility for a permanent creative **co-operation**" (p.152-3).

In some way, USOMID seems to be related to JOHANNESSEN's **heterarchical** concept of the **organization**.

For details on this **methodology**, practiced in Slovenia since 1980, see MULEJ's bibliography in the referenced paper.

A quite complete description of the USOMID **methodology** has been made by T. ECIMOVIC et al., in their 2002 study of "System thinking and climate change", published at the Maribor University in Slovenia (2002, section 4.5)

3700

UTILITARIANISM in a systemic perspective ¹⁾³⁾⁴⁾

Utilitarianism is generally seen as an individualistic world view. However, if the individualistic view is irrestrictively adopted, it may easily lead to wilful ignorance or negation of social utility. Such a view, in turn, easily leads to individual **actions** which directly or indirectly undermine the very conditions that permits individual utility itself. On the contrary, the ignorance of the competitive **role** of the individuals leads to the impossibility to discover new **behaviors**, possibly valuable for the **whole group** or society.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Thus the systemic view should aim at a better harmony between the individuals (i.e. belonging to the **parts**) view and the systemic view (i.e. social, i.e. on the whole)

J. BRYANT debates these aspects (1991, p. 176-180, and 184). He enounces for ex. the following theorem: "A necessary and sufficient condition for the maximization of expected group utility is the free flow of **information** among members of that group"(1991, p. 177)

Curiously altruistic utilitarianism can be used in two different ways:

- closely practiced, as for ex. in mafias
- widely practiced, as through utopian **ideologies**

This shows the fuzzy character of this concept, and the need to avoid simplistic views.

→ **Behaviorism**

V

3701

VALIDATION ³⁾ - 4)

The (mostly consensual) **process** of recognizing the soundness of a theory, **method**, concept or **model**.

Validation is always referred to a prior system of values or **concepts**, accorded within an **epistemic community** through explicit or implicit **consensus**.

"Truth" or "reality" can never be guaranteed in an absolute way by any theory, concept or **model**, even if constantly and carefully re-validated (see "**ontologic skepticism**").

J. WARFIELD enounced a "Law of Validation": "The validity of science depends upon substancial agreement within the scientific **community** of meaning at its highest grade, i.e. meaning attained through **definition by relationship**". As observed by WARFIELD himself. this "is a necessary, but not in general sufficient condition for scientific validity". One of the main difficulties is that "... interpretations are crucially dependent on **language**. The **language** itself is one of the implicit aspects of **systems thinking** and of science in general" (1988, p.337).

Other problems are:

- **Consensus** on new **concepts** or **models** can be long delayed by a dominant **paradigm** (Remember WEGENER about continental drift and MILANKOVICH about climatic cycles).
- **Consensus** is frequently more easy on abstract formalizations and **models** – logical or mathematical – than on practical applications.

3702

VALIDATION (Model) ²⁾³⁾

J. CASTI enumerates as follows some criteria along which the **validity** of any kind of models should be established (1997, p.11):

"**Operational**: Is the model able to provide answers to the questions for which it has been built?"

"**Empirical**: Does the model agree with observed **data** that are relevant to the problem under consideration?"

"**Theoretical**: Does the model contradict any established **theories**?"

"**Consistency**: Does the model contain any logical contradiction?"

"**Faith**: Do specialists in the area being modeled agree that the model produces believable results?"

"**Testing**: Can the model be tested in the real world?"

Of course, some new models may "contradict established **theories**". In such cases, we need a thorough discussion to evaluate if there are really contradictions and, if so, to find out their causes.

As to the "believable" character of the results, it depends on the "**beliefs**" of the evaluators, whose **frames of references** should be clearly stated and possible also re-evaluated. Let us remember of the general and protracted opposition of mainstream geologists, from the 1920's on, to WEGENER's views about continental drift, later to be confirmed by plate tectonics.

Invalidation, as well as validation, must always be deeply justified.

3703

VALUATION TERMINOLOGY ¹⁾²⁾³⁾⁴⁾

Many usual qualifying terms should be closely scrutinized from a systemic viewpoint because they introduce implicit cultural biases, which remain hidden to most of the users.

Examples are words like "acceptable, admitted, normal (or abnormal), recognized, relevant, satisfactory, useful (or useless)", etc...

Any research, specially directed at **human systems**, should define clearly to whom, in what cases, in which places and times something is "acceptable", etc...

In system's **modelization** of any type **fuzzy** valuations are at the same time very difficult to avoid, and in case of use, difficult to place in perspective and, still more so, to quantify when needed.

Many **issues** are thus obscured and, in cases, this can lead to serious errors and abuses.

3704

VALUE (Economic) ⁵⁾

The monetary pricing or **assessment** by a specific society at a specific time of a natural or artificial item.

While the fact is generally understated or ignored, economic value is obviously always the result of a dominant - but variable - cultural or social **consensus**, as shown for ex. by some extravagant speculation episodes, like the tulip craze in Holland some centuries ago.

Inversely, some material **resources** that were without economic value in the past, may acquire one as a result of some technological advance. The case of oil is a striking example. Genes are now similarly acquiring an economic value (D.F. VIVIEN, 2000, p.88).

According to VIVIEN, economic value can be considered from three different angles:

- value for what kind of use
- value for whom
- value for what **time**, i.e. present or some short or long time future.

However, the notion has many times a controversial relation with ethical and social value, much more difficult to assess. This may lead to deep and conflictive changes in **social systems**.

A case is the controversy about the value of the planetary **ecosystem**, or planetary **commons**, which pervades all debates about preservation or conservation of natural **resources** of all kinds.

3705

VALUES ³⁾ - 4)

The basic **rules** which govern the individual and collective **behavior** of the members of a **human system**.

According to the "Glossary of environmental education terms" of UNESCO – UNEP: Values are "formed by **groups** of attitudes which cluster. Values produce **behavior** as contrasted to attitudes which represent a behavioral disposition potential or tendency. Values are individual or collective conceptions (based on) emotional, judgmental and symbolic **components** of that which is of worth, important, or desirable" (UNE Glossary, 1983, p.29).

This formulation is somewhat objectionable: in effect, values are proper to *groups of people* whose attitudes become clustered, i.e., values are **abstractions** if not translated into **behavior**.

For N. RESCHER, values are instrumentalities for reasoning about alternatives (Quoted by K. SAYRE, 1976, p.185). SAYRE adds: "What makes values important principles of social **cohesion** is that they contribute so effectively to the formation of personal **habits**. The emphasis upon reasoning is understandable, however, in that values also play an important role in the

public justification of problematic courses of **action** and the values supporting it must be understood commonly by all parties involved" (Ibid).

A. LASZLO explains the mechanism of values **action** on individuals and **groups** in the following way: "... **cognitive maps** must involve values. Values are **symbols** that serve to record **phenomena** and that catalyze **reactions** to them. On an individual **level**, **cognitive maps** are conditioned by the values and beliefs that are dominant in society at the time. By internalizing values derived from cultural **contexts**, individual **maps** incorporate a certain amount of developmental leeway. Values encourage repeating **behavioral** sequences, forming stereotypes, and performing rituals. Much of the **information** in these media, **information** on which individual **maps** depend, is transferred from others. Thus human mental **maps** can be constructed without direct experience. The nature of these **learning processes** contributes to making our **cognitive maps** socially constructed realities.

"Within a given **culture**, values and beliefs are relatively coherent. As a result, it is possible to talk about a collective or societal **cognitive map** of the **environment** (social, cultural, as well as natural). It describes the dominant **world-view** in a given **culture** at a given **time**" (1993, p.318).

Values are the basic references for **regulations** in any fundamental aspects of human systems. They are the sources of **norms** and standards.

G. VICKERS states: "The problems of the traffic **regulator** are set by the **standard** of congestion, which is regarded as unacceptable. Without such a **standard** there would be no problem and nothing to regulate" (1967, p.60).

Of course, this would mean radical anarchy and could make life downright impossible for many people.

Thus: "All **regulation** depends on setting standards by a **process** of human valuation" (Ibid).

Such a **process** can be successful only through open or tacit **consensus** by a clear majority of the interested people. Any authoritarily imposed standard brings some kind of **stress** in the social fabric.

Consensus, in part, is in turn based of more general and permanent cultural values. For this reason, we should pay much attention to the following comment by VICKERS: "We now seem to be approaching a point at which the **changes** generated within a single generation may render inept for the future the skills, the institutions and the ideas which form that generation's main legacy to posterity and the next generation's principal heritage" (Ibid, p.61).

This is a very serious problem, because values are necessarily transmitted from generation to generation through **education** and **training**.

In other words, our traditional social **regulators** are at great risk... as well as ourselves, as a result.

This becomes still clearer when, as stated by F. PARRA LUNA: "... the ideal system of values ... (is) defined by those in command" (1993, p.423).

Formerly, values **stability** was guaranteed by the **autopoietic** way those "in command" received their values through traditional **education**. Their leeway for interpretations was very limited. But this is not anymore the case...

3706

VALUES (Organic and mechanistic)^{1) - 3)}

P.L. BEUKEMA proposed the following comparative taxonomy of organic and mechanistic values (1974, p.255, hereafter reproduced in a shortened form):

ORGANIC	MECHANISTIC
Reward and recognition	Reward or punishment
Warmth and support	Formal support and objectivity
Task clarity and flexibility	Hierarchy and rational organization
Individual responsibility	Restrictive supervision
Confrontational conflict management	Forced conflict management
Collegial-supportive authority	Autocratic-custodial authority
Multi-dimensional communication	Bi-dimensional communication
Growth and innovation	

3707

VALUES TRANSMISSION MODES^{1) - 4)}

The transmission of values is basically a social **autopoietic process**: Values constitute a global **code** of prescribed or prohibited **interactions** within society. Their permanent use is the constant reconstruction of these **interactions** through the conditioning of the individuals whose **role** is to permanently reconstruct the social fabric.

A.P. VARDOMATSKY enumerates the following social and psychological **mechanisms** responsible for values transmission:

"- Social expectations (which)... in a close **environment**... offers a personality a certain **set** of social **roles**...

"- Suggestion... the **transmission** of **information** based on the uncritical attitude. Here the authority of the one who suggests is necessary

"- "Infection"... the **transmission** of certain emotional **states**. It is a non-verbal **process**

which takes place on the basis of collective **activity** as a result of a kind of mental induction. The power of excitation is proportional to the size of the audience. See R. DAWKINS "memes".

"- Imitation is the reproduction and **transmission** of **behavior models**... Imitation can be blind or conscious...

"- Conformity is a synthetic trait of a personality to be complaisant to the pressure of the **group**. If this complaisance is very strong and extends to **ideology** and morality then conformity, I believe, transforms to conformism" (1993, p. 493).

3708

VARIABILITY 1¹⁾

The individual differences between **living systems** pertaining to the same basic type.

N. BOTNARIUC states that variability "is an individual **level process**, its adequacy deriving from the very principle of **organization** and functioning of **open systems**".

Conversely: "**Adaptation** is a **population** or species **level process**... different in nature from adequacy; it is the result of the historical action of natural **selection**, which changes individual variability in **adaptation**" (1966, p.97-98).

3709

VARIABILITY 2²⁾

Temporal **variations** within a system induced by outside influences, generally **rhythmical** or **cyclical**.

This notion, introduced in this meaning by W.D. GROSSMANN and K.E.F. WATT (1992, p.8), implies a kind of consonance between the system and its **environment**.

The authors state: "... other **variations** emerge from within the system such as the heartbeat in mammals, fashions, **changes** of attitude, or **change** due to **learning** and inventions, genetic **drift** or some erratic **events**" (Ibid).

This seems a somewhat mixed bag. More or less regular **environmental variations** may evoke *characterized* variability in a system (**variations** of **metabolism**, for instance). The **limits** of this variability are fixed by the **organizational closure** of the system, combined with its **learning** capacity. Erratic **events** induce variability only if the system is equipped with the needed **variety**. If not, it would be destroyed.

F.K. BERRIEN, inspired in ASHBY's **homeostat**, expressed this as follows: "The variability of a system's **outputs** is limited by a finite number of **functions** which a given **component** may perform and a limited number of **states** which the total system may assume. The **limits**, even with a relatively simple system, are wide" (1968, p.55).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3710

VARIABLE ^{1) - 2)}

"A measurable quantity which at every instant has a definite numerical value" (W.R. ASHBY, 1960, p.14).

ASHBY states: "... every real '**machine**' embodies no less than an infinite number of variables, all but a few of which must of necessity be ignored... Faced with the infinite number of variables, the experimenter must, and of course does, select a definite number for examination – in other words, he defines an **abstracted system**...

"Because any real '**machine**' has an infinity of variables, from which different **observers** (with different aims) may reasonably make an infinity of different **selections**, there must first be given an **observer** (or experimenter); a system is then defined as any **set** of variables that he selects from those available on the real '**machine**'. It is thus a list, nominated by the **observer**, and is quite different in nature from the real '**machine**'. (Ibid, p.15-16).

As to G. PASK, he put it in this way: "Attributes of an assembly are identified with the variables in a mathematical **model** to form a system" (1961a, p.116).

Also G. KLIR states that "A variable is always an abstract (mathematical) thing. It may, or may not represent some observable or measurable attribute of the real world" (1991, p. 47).

As a consequence, systemic **models**, when formalized, are **sets** of **interconnected** variables.

As the **concept** of 'variable' implies the comparison of different values at different instants, it implies also by necessity a reflexion about the **concept** of **time**.

3711

VARIABLE (Basic) ²⁾

Any variable specific to the system and whose **changes** are relevant for the **model** to be constructed.

The **model** must also take **supporting variables** (general conditioning ones) in account.

3712

VARIABLE (Coenetic) ²⁾

A variable which is "the common causal determinant of the **state** of both the **environment disturbance** and the **situation** at the same **time**" (S. BEER, 1968, p.285).

The **concept** was created by G. SOMMERHOFF and reflects the unavoidable fact that any system is linked to a specific **environment** which may disturb it.

Thus, in many cases, the separateness of a system is partly an illusion (Ibid, p.391), and we should scrutinize its **environment** whenever an internal **disturbance** appears.

3713

VARIABLE (Command) ²⁾

"An internal variable of a system which is under the control of a **decider subsystem**" (B. WALLISER, 1977, p.129).

WALLISER distinguishes two classes of command variables:

Control variable: A command variable with continuous effect in **time**. This is practically equivalent to a **regulator**.

Decision variable: A command variable operating discontinuously in **time**. This type corresponds to more or less frequent direct interventions of the **decider**, who may for example modify the calibration of a **regulator**.

3714

VARIABLE (Critical) ²⁾

A variable that must be maintained between a specific maximum and minimum.

If this condition is not respected the result is generally the destruction of the system. Different **interconnected** critical variables may regulate reciprocally, as for example in ASHBY's **homeostat**, endowed with **ultrastability**. As expressed by St. KAUFFMAN: "Those variables must be kept in bounds by the coordinated dynamical **behavior** of the system coupled to its environment" (1993, p.524).

3715

VARIABLE (Environmental) ^{1) - 2)}

Any variable **exogenous** to the system considered, which exerts an influence on it.

Some environmental variables are easily and generally perceived. Some others remain ignored or occult.

The system's **equilibrium**, and even sometimes its **survival** may however depend on a correct **perception**, and eventual satisfactory **management** of the **responses** of the system to some critical environmental variable. Consequently their **monitoring** is important to verify that they remain within **limits** compatible with the system's needs and to decide some adaptive **action**.

3716

VARIABLE (Flow) ²⁾

A variable which controls the exchange of **matter**, **energy** or **information** between **subsystems** within the system, or between various systems within a common **environment**.

This notion has been widely used by J. FORRESTER in his **Systems dynamics**.

3717

VARIABLE (Goal-seeking) ²⁾

A variable which enhances the capacity of the system to reach a specific **goal**.

G. KLIR states: "By applying (such a) variable as an additional **input** to the **goal-implementing element**, its **performance** with respect to the **goal** increases" (1991, p.146).

KLIR also explains how a goal-seeking variable should be selected, adding that "The main difficulty in selecting a proper goal-seeking variable is that its influence upon the **goal** variables is usually not fully known" (p. 148) and must thus be previously investigated.

3718

VARIABLE (Relevant) ^{1) - 2)}

A variable whose **variations** *practically* matter for the system's **behavior**.

Sun flares do not seem to influence *notably* the timetable of railways systems. However, blizzards may do. One and the same variable can be relevant for one system and irrelevant for another one. Tides are relevant for harbours and navigation lines, but are not for bus lines (save f. ex. in case of being them connected with a ferry line).

There are also degrees of relevance: some variables do continuously condition the system's **behavior**, as for example voltage for a sawmill; some others have only incidental relevance.

A normally irrelevant variable may sometimes become crucially relevant, as for example a forest fire for the global **ecology** of a national park.

Generally, variables are considered relevant when their influence is permanent or frequent, mainly in relation to the **goals** assigned to the system.

Serious problems may however emerge when, for some reason, relevant variables remain hidden from the **observer**.

3719

VARIABLE (Sliding) ²⁾

"The **linear** combinations of some quantity and its temporal derivatives (J.J. SLOTINE, 2002, p. 19)

Such variables are widely used in **controls**. They can be selected in order "to reduce a problem at some **level** into a first order one, much easier to solve. This corresponds to the mathematical creation of series of contractant **modules**" (Ibid)

→ **Contraction**

3720

VARIABLE (State) ²⁾

"A variable which indicates the **accumulation** of some quantity in the **time** dimension".

J.de ROSNAY observe that it "thus indicate the result of an integration" in the mathematical sense (1975, p.91).

3721

VARIABLE (Supporting)²⁾

A variable of general character "within which **changes** in **states** of the basic variables occur" (G. KLIR, 1991, p.49).

"The most frequent examples of supporting variables are those representing **time**, **space**, or various **populations** of individuals at the same time" (Ibid).

3722

VARIABLES as percepts³⁾

According to W.T. POWERS et al "A variable is always a combination of two classes of **percepts**. One class contains **percepts** which do not vary: by these **percepts** we keep track of the "identity" of the variable. The other class contains **percepts** which do change: these **percepts** carry the **information** about the "magnitude" of the variable. "Magnitude" is used here in its most general sense, including the meanings of "intensity", "size", or any other word for the general class of variable attributes" (1960, p.63).

It is of course useful to be remembered about this non-mathematical origin of the concept of variable.

3723

VARIANCE²⁾

The total number of conditions which define a system and may be modified without destroying it.

Variance is closely related to **variety**, considering that the possibilities for **variation** depend on the richness of the **repertory** of the systems possible **states**.

The **limits** to variance are closely related to the nature of the system and must respect **compatibility** with its capacity for **autopoiesis** and its necessity for **dynamic stability**.

Moreover, a major potential variance implies a maximum of **autonomy** for the system.

3724

VARIANCE ANALYSIS²⁾

Any technique aiming at making **predictions** about the **behavior** of a **variable** or system on base of its former **behavior**.

The technique to be employed should correspond to the nature of the system, as for example, fully **linear** or **deterministic**, **ergodic**, or **chaotic**.

3725

VARIANCE (Co-)^{1) - 2) - 4)}

Reciprocal adjustment **process** between a systems internal **variations** and its **environment's variations**.

The degree of co-variance between the system and its **environment** depends basically upon their acquired **state** of reciprocal **adaptation**, obtained through the accumulated action of their more or less conjugated **evolution**.

Thereafter, it is always possible that unprecedented environmental **variations** should produce:

- either a new type of **adjustment** in the system,
- or its destruction.

However, co-variance also may produce inverse effects.

Life deeply modified our planet's atmosphere through the geological times and did transform the earth's crust, with the shaping of calcareous rocks by marine **organisms** or the genesis of mineral oil.

The **emergence** of some superior animals, and notably of man tends to put still more in reverse the **process** of reciprocal **adjustment**. Specially man tends to take evermore initiatives aiming at wide environmental **transformations**. However, the **environment**, in turn, is starting to "retort" more and more forcefully.

The importance of the **process** of co-variance is likewise obvious for human systems as for example enterprises, or in macro-economy problems, or in **prospective**.

3726

VARIETY^{1) - 2)}

1)"Given a set of **elements**... the number of **elements** that can be distinguished" (W.R. ASHBY, 1951, p.167).

2)"A measure of **uncertainty** or the amount of **selection** needed to remove the **uncertainty**" (G. PASK, 1960, p.116).

ASHBY explains: "Thus the **set** {gbcgbc} has a variety of 3 letters... For many purposes the variety may be more conveniently measured by the logarithm of this number. If the logarithm is taken to base 2, the unit is the **bit**. The context will make clear whether the number or its logarithm is being used as measure" (Ibid).

Generally it is now understood that the measure of variety is expressed in **bits**. Using this base, a **bit** is the quantity of **information** needed to reduce **uncertainty** by half. (thus the connection between ASHBY's and PASK's definitions).

Variety as a concept may look deceptively trivial. However, a still quite simple system, as ASHBY's **homeostat**, with 4 **elements** and 25 different possible positions for each of them offers already a variety of 25^4 , i.e. 390.625 combinations. Really **complex system's** variety overcomes our imagination and, in order to give them some definition, **constraints** become an absolute necessity.

3727

VARIETY and COMPLEXITY¹⁾

Variety, in ASHBY's sense, is the condition for **complexity**.

J.de ROSNAY explains it in the following way: "The **growth** of a **complex system** – in volume, **size**, or number of **elements** – depends on **positive feedbacks** and **storage** of **energy**. Indeed, a **positive feedback**, when always working in the same way, results in the accelerated **growth** of some specific **magnitude**. It may be the **number** (**growth** of a **population**), **diversity** (variety of the **elements** and of their **interactions**), **energy** (surplus of **energy**, profits accumulation, capital **growth**).

"The **positive feedback** is equivalent to a **random variety generator**. It enlarges the slightest difference. It increases the possibilities for **choice**; accentuates **differentiation** and generates **complexity** by multiplying **interactions** possibilities.

"Variety and **complexity** are strongly related. But variety is at the same time one of the conditions of **stability** of any system. Indeed, **homeostasis** can appear and subsist only through a very great variety of **regulations**. The more complex the system, the more complex the **control subsystem** must be, in order to match the multiple **perturbations** coming from the **environment**. This is what the *Law of Requisite Variety* (proposed by W. Ross ASHBY in 1958) expresses. This Law, extremely general, establishes in a mathematical form that a system's **regulation** is efficient only if it relies on a *control system as complex as the system itself*. In other words, **control** actions must have a variety equivalent to the variety of the system. In **ecology**, for example, it is the variety of species; the number of ecological "**niches**", the wealth of **interactions** between species and between **community** and **environment**, which guarantees the **stability** and permanence of this **community**. Variety allows for a very extended supply of **responses** to the possible forms of aggressions from the **environment**".

Variety is thus clearly correlated to **size**.

de ROSNAY still adds: "Variety generation may thus lead to **adaptations** by increasing complexity. But by confrontation with **environment's randomness**, it generates also the *unexpected*, which is the source of **change**. **Growth** is thus at the same time the prime mover of **change**, and the way to adapt to the **environment's** modifications. One glimpses the way through which a **homeostatic system** may evolve, while constructed to resist **change**. It evolves through a complementary **process** of desorganization (partial or total) and of reorganization. This happens either during the clash of the system with **random perturbations** from the **environment** (mutations, **events**, **noise**), or during the readjustment of some **desequilibrium** resulting, for example, of too fast a **growth**" (1990, p.120).

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3728

VARIETY and ENTROPY¹⁾

J.L. LE MOIGNE established the noteworthy following relation between variety and entropy: "The variety V of a system is in bi-univocal correspondence with its entropy E. As entropy grows more and more, variety decreases steadily".

One could state a quite similar idea by saying that entropization leads the system from (organized) **heterogeneity** to (inorganized) **homogeneity**.

It should however be observed that this is strictly true only for the systems that remain close to the **steady state**, or for the absolutely theoretic and abstract **model** of the **isolated system**.

On the contrary, systems faraway from the **steady state**, may emerge toward a higher degree of **organization**, if they undergo giant **fluctuations**. In this case **dissipative structures** may appear and lead to a growing entropy production.

However, the bi-univocal relation pointed out by LE MOIGNE reappears when the new system reaches at its own **level** a new **steady state**.

3729

VARIETY (Distributed)^{1) - 2)}

In a **population**, the scattering of basic characters among numerous individuals.

H.G. BURGER describes this situation as follows: "Instead of **reserve** being latent, as in plasticity, it can be ready-formed, manifested in **diversity**. Each individual can then specialize and utilize all his talents without the overhead burden. Such a scheme provides multiple, variant individuals within a species. Each specimen need incorporate a **random** part of the potential range..."

"Should emergency arise, those individuals with the appropriate talents survive. The others perish" (1967, p.210).

This concept is useful in sociology and economy as well as in biology and **ecology**.

Incidentally, BURGER uses the term "**reserve**" instead of variety. His description thus links variety with the existence of **reserves**. This is a bridge between VENDRYES's concept of the **counter-aleatory** role of **reserves** and ASHBY's concept of **requisite variety**.

3730

VARIETY (Law of optimum)^{1) - 2)}

Such a law has been proposed by N. PARITSIS in the following terms:

"... for a given **organism**, **environment** and **time**, there is an optimum variety (and **information**) in the **environment**, which

a) is as low to enable the **organism** to be adapted on the basis of its **requisite variety**,

b) is as high to allow and induce **development**,

c) at the same time does not produce **overload** or **underload stress**.

"This optimum variety has also an optimum **rate** of gradual increase that results to a combination of higher and safer development and **evolution**" (1992, p.37).

It must be stressed that, as stated by PARITSIS himself, optimum variety expresses an **environment's** property in relation to a specific **organism**.

PARITSIS also observes that variety in the **environment** implies the need for adjustment **processes** in the system, as stated by J. MILLER.

3731

VARIETY (Limits to)²⁾³⁾

"The limits to the number of possible **states** of a system (1998 c, p. 56) (variety used in the sense of s-variety I identified in my earlier piece, that is, the number of states possible within a system)" (R. GLANVILLE, 1998 a)

The most general limit to variety is **BREMER-MANN'S limit**, based on this author concept of the whole matter content of the universe (hypothetized as closed, of course) "as a perfect and ideal atomic **computer**".

Starting from such a view "the world has vastly more variety than any one of us can dream of having" (1998 c, p. 62)

GLANVILLE concludes: "This means that we are left with two options. To try to control the world by reducing its variety (leading to a very restricted and normative life), or to go with it, accepting that it is beyond our **control** and enjoying the novelty it offers us through its variety" (Ibid)

These options appear in any practical **situation** or **issue**: we would ideally need to strike a convenient balance between control and **openness to creativity**.

In fact, excessive control may lead to sterility and paralysis, while insufficiently controlled creativity veers easily onto **anarchy** and **disintegration**.

→ **Bottom up; Organization; Top down**

3732

VARIETY (Maximum proper)²⁾

The variety of a system as "determined by the product of the **degrees of freedom** of each of its **subsystems**" (F. HEYLIGHEN, pers. comm.).

HEYLIGHEN comments: "In general it seems sufficient to remove certain (inadequate) **constraints** in order to increase the **variability** of the system. However it is clear that variety cannot be increased indefinitely in this way... If we want to increase (it) beyond this limit we will have to increase the number of **subsystems**, in accordance with TURCHIN's proposed mechanism (of **meta-control emergence** or building" (Ibid).

3733

VARIETY (Requisite) (Law of)

"Only variety can destroy variety" (W.R. ASHBY, 1956,, p.207)... or

"R's Capacity as a **regulator** cannot exceed its capacity as a **channel** for variety" (W. R. ASHBY, 1951, p.171).

In other words, the **efficiency** of a **regulator** in resisting **environmental disturbances** depends of the number of countervailing options it can produce.

For a system, this means that its **regulators** are able to maintain the system **organization** only to the extent that they can produce alternative **states** for any **perturbation** imposed by **environmental noise**.

Explain H. ATLAN: "This law is important... to understand the minimal conditions of **structure** needed for the **survival** of any system depending on an **environmental source** of aggressions and **random perturbations**.

"Let us consider a system exposed to a number of different possible **perturbations**. It has at its disposal a number of **responses**. Among the multiple possible **states**, only some are "acceptable" in view of the **finality** (at least apparent) of the system, which may be its sheer **survival** or the accomplishment of some **function**. The **regulation** is meant as choosing among the possible **responses**, those that will place the system in an acceptable **state**. ASHBY's law states a relation between the variety of **perturbations**, the one of **responses** and the one of acceptable **states**. Variety of **responses** must be bigger if variety of **perturbations** is big and the one of acceptable **states** small. In other words, a great variety of available **responses** is needed in order to insure a **regulation** in a system such as to maintain it in a very limited number of **states** while submitted to a great variety of aggressions. Still more, in any **environment** being a **source** of variable and unforeseeable aggressions, variety in the **structures** and **functions** of the system is an requisite factor of **autonomy**" (1972, p.25).

This celebrated law was proposed by W.R. ASHBY in 1956. R. VALLÉE comments it in the following way: "Schematically, this principle, which is still controversial, as restated by R. CONANT (1969, p.334-6), says that the ability of a **feedback** device (for example a **regulator**) to resist successfully to a perturbing **noise**, increases with its capacity to transmit a greater quantity of **information**, per **time** unit, through its **feedback** chain. We have here a concept derived from SHANNON's theory (the capacity to transmit **information**) and an idea coming from **games theory** (the ability to resist to an opponent), the variety requisite for achieving the chosen **purpose**, being the variety of **informations** transmitted per **time** unit" (1993a, p.88).

In very complex **interrelations** between a system and its **environment**, it is not possible for the system to obtain absolute **control** over its **environment** because there is an upper **limit** to the **variety** that the system may contain.

3734

VARIETY (Spatial) ²⁾

W.D. GROSSMANN and K.E.F. WATT (1992) introduce the notion of spatial variety which refers to the spatial differentiation within systems, as different from their possible temporal **variations**, related to ASHBY's **variety**, and which they call **variability**.

Spatial variety is defined by a more or less high degree of fineness in spatial differentiation, or, to the contrary to its coarseness. They use the term "grain" in this meaning. The notion is applicable for instance to **ecosystems** or to human **organizations**.

3735

VARIETY (Structural) ²⁾

The **set** of connected **structures** in a system.

3736

VARIETY ENGINEERING ⁴⁾

The practical ways to make **controls** efficient in **human systems**.

S. BEER, who introduced the concept, states that "The manager is a variety engineer" (1979, p.39).

Variety engineering uses two complementary techniques: either reducing the impact of the **environmental** variety, or enhancing the variety of the system itself.

So-called **cyberfilters** (p.499-509) can be used to reduce the **environmental** variety admitted by the system, while internal variety can be increased. Both **processes** should be applied at the different **levels** in the system: In **subsystems** in response to **disturbances** emerging from specific systems in the environment; and in the system as a **whole** connected to the general **environment** (R. ESPEJO, 1977).

The human aspects of variety (**values**, **norms**, attitudes, etc...) represent however a mined field for variety engineering.

3737

VARIETY GENERATOR ²⁾

A device which is capable of proliferating variety.

As stated by St. BEER such a device is: "... not necessarily a machine made of ironmongery". He adds that it may be "... deliberately organized to generate (variety) for a **purpose**. ... the **purpose** is not known in advance, although of course the *kind* of **purpose** is known" (1968, p.297).

A grid on a **map** is a good example: it differentiates **locations**, or at least permits their differentiation when needed. Any variety generator creates opportunities for **selection** within a wider pool of possibilities.

3738

VARIETY RATE ²⁾

"The variety that a system is able to show during a given interval of **time**" (J.L. LE MOIGNE, 1977, p.167).

This quite significant complement to the concept of variety was introduced by VAN COURT HARE (quoted by LE MOIGNE).

Of course, most systems are only able at a given moment to use a reduced part of their total variety. Thus, even if they count, in principle, with the **requisite variety**, it does not follow from this that they will be able to use it.

This potential problem seems quite serious for **complex systems** of very wide dimensions, doubtless partly due to the length of their **communications** lines.

3739

VARIETY REDUCTION ^{1) - 2)}

The **process** of **simplification** of a system's model by **aggregation** of *similar elements* or **interrelations** and the elimination of *irrelevant* ones.

Statistical **methods** based on the use of the **law of great numbers** are a very general technique for variety reduction.

No **model** can ever be complete, i.e. **isomorphic** to the **situation** or system. On the contrary, it must be enormously simplified if it is to be manageable and useful. Variety reduction is however a tricky proposition: "**similarity**" or "**relevance**" are based on more or less subjective **criteria**, whose use may be difficult, particularly in borderline cases.

An historic example is given by the multiple – and sometimes, quite divergent – criticism directed at the Club of Rome's **World models**.

Variety reduction is also linked to the **resolution level** sought in relation to the type of **situation** to be studied.

In a different meaning, variety reduction must at times be applied to **human organizations** or **systems** wherein an excessive proliferation of **elements**, or **subsystems**, or redundant products is observed. This is a fundamental issue in controlling bureaucracies.

3740

VARIETY REDUCTOR (Perception as) ^{1) - 3)}

Any perceptor acts as a selective filter. This is true about physiological **perception**: our detection of electromagnetic waves is strongly limited. It is also true about psychological **percep-**

tion: we suppress much of our potential capacity of **perception** by focusing on specific and chosen items or topics.

→ **Perception (selective)**, **Perceptive filter**

3741

VARIETY REDUCTOR (Statistical inquiries as) ²⁾

A statistical sampling can be used as a variety reductor since it *reduces redundant information* contained in thousands or millions of **data** into a shortened synthesis which, provide correct use of statistical **methodology**, contains nearly all the **information** in a practically usable form.

A good example is the use of demographic statistics by life insurance companies and, more generally, any statistical inquiry used by any company or public administration board to understand its **environment** and take relevant **decisions**.

3742

VECTOR ²⁾

"An ordered **set** of numbers that specify the values of **variables**" (G. PASK, 1961a, p.116).

A vector completely specify a quantity and a direction.

3743

VENN DIAGRAM ²⁾

A two-dimensional graphical **representation** of the intersections of different **sets**.

The **representation** is based on intersecting closed curves representing the various areas corresponding for example to a, non-b, non-c; a, b, non-c; a, b, c; ... non-a, b, c; etc...

However, the great difficulty was to represent the intersections of more than 3 **sets**. This problem has now been solved by A. EDWARDS of the Gonville and Caius College of Cambridge University, England (1989, p.51-6). EDWARDS uses "toothed" curves, by means of which he obtains a kind of **fractalization algorithm** that allows for the highly symmetrical **representation** of the intersections of any number of **sets**. These VENN-EDWARDS diagrams are a great help for visualizing complex **interrelations** between many systems.

Multidimensional and multi-layered Venn diagrams are now used to classify complex and overlapping statistical **data**.

Patrick BALL, deputy director of the Science and Human Rights Program of the AAAS is using this kind of diagrams to order the multiple data about different types of violations of human rights by different people or groups in many places and times (W. GROSSMANN, 2003, p. 48-51)

This method is useful to control **reliability** of testimonies and obtain an **evaluation** of the **density of reporting** in specific cases.

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

3744

VIABILITY¹⁾

The condition of a system able to survive after birth, to **grow** and to reach enduring **dynamic stability**.

This is, generally speaking, the condition of **autopoietic** and **autonomous systems**.

W.D. GROSSMANN and K.E.F. WATT understand viability as "temporal **variety**" and discuss this notion as follows: "To be viable, systems must have manifold features that will allow them to withstand the impact of expected as well as unforeseen and erratic **events**. It would be desirable to have systems that could even benefit from the unexpected" (1992, p.5).

The authors state that viability transcends C.S. HOLLING's idea of **resilience**, because it "... includes the notion of coming into existence and ultimately **disintegrating**" (Ibid).

According to them: "... **diversity** may in some cases contribute to viability" (Ibid).

This is acceptable if **diversity** is **variety** in ASHBY's meaning, or systemic internal **heterogeneity**, when various **functions** or **groups** can contribute numerous and varied **adaptations**.

As **diversity** is commonly antagonized by uniformization (as in chain production, for instance), or autocratic and limiting **control**, so could be viability. However, **diversity** should necessarily remain within the limits of **organizational closure**, to allow for **coherence** in the system.

According to E.von GLASERSFELD viability has its meaning in the cognitive domain: "Briefly stated, concepts, theories, and **cognitive structures** in general, are viable and survive as long as they serve the purposes to which they are put, as long as they more or less reliably get us what we want" (1988, p.138).

Such a view is closely related to POPPER's "falsification" and KUHN's shifts of **paradigms**.

From a similar viewpoint, Systemics will be viable only if it will produce practical **responses** to complex **issues** that former **methodologies** and theories cannot give.

3745

VIABILITY DOMAIN²⁾⁴⁾⁵⁾

The limits wherein a system must remain in order to insure its **survival**.

The concept is clear in Biology. Any system that starts with some lethal gene will not survive very long time.

Moreover if it produces some offspring, these will be at an evolutive disadvantage in relation with more favorably endowed beings.

On the contrary, a **mutation** may enhance the **survival** potential of the system by expanding the **environment** in which it will be able to survive.

In social systems however it is much more difficult to evaluate how their viability can be affected and in which **limits** by some extrinsic or intrinsic condition or **event**.

→ **Artificial life**

3746

VICINITY²⁾

Proximity in space.

In **topology**, the vicinity of two points is defined by their common membership in a **set** or in a **basin**.

Vicinity is a near synonym for **neighborhood**.

3747

VIEW¹⁾²⁾⁴⁾

A projection of a complete **model** of some **situation** or system composed from different partial perspectives (or views) on to a particular **subject**.

J. LIND (2000, p. 640-1), who proposes this...view, distinguishes:

- the **task** view through which a task **hierarchy** is generated to determine the basic **problem solving** capacity or possibilities available
- the **environment** view which considers the nature of the **relationship** of the system with its environment
- the **role** view which "determines the functional **constraints** that characterize the capabilities of the different active **agents**"
- the **interaction** view which considers how the needed **communications** among active agents must be ordered in function of the pursued **goals**
- the society view seeks a model consistent with the **roles** as they are accepted and interconnected within the society
- the architectural view "is a projection of the general **organization** needed to manage a specific **situation**. It includes for ex. "**agent management** or database **integration**"
- "the system view which seeks a kind of final coordination dealing "with aspects that affect several of the other views at the same time or even the system as a **whole** (loosely summarized from A. LIND's paper, who aims at practical management uses)

→ **Design; Design (Generic); etc...-Management; Multi-agents system**

3748

VIEWPOINT^{1) - 3)}

The peculiar angle under which an **observer** focuses his or her attention on a complex **situation** or system.

R. ESPEJO stresses that "**Complexity**, as opposed to **variety**, is something that results from the **interaction** of the viewpoint with the **situation**. **Complexity** is in the eye of the beholder" (1988, p. 140).

Variety itself, is intrinsic and, save in very simple theoretical examples, never completely observable, because it becomes readily gigantic. St. BEER observed that 7 **elements** could have 2⁴² possible **patterns** of **interaction** in time.

Much reduced descriptive **models** of **complexity** are extracted from potential or real **variety** by specific ways of observing systems. Moreover, **descriptions** by different **observers** may not coincide ... and generally do not.

Even the same **observer** may very well describe a system or **situation** in different ways, according to his or her interest at the moment.

Moreover, any personal **description** is generally biased, even unknowingly, by the **observer**.

Better **descriptions** are in principle made by **groups** of **observers** from different viewpoints, and still more so if they use reasoned **criteria** and seek **consensus**.

It should also be taken in account that personal or shared viewpoints do not remain permanent in **time**, being influenced by **learning**, experience, debate, etc...

Stressing the importance of viewpoints will help systemists to avoid becoming doctrinaires liable to theoretical abuse.

→ **Weltanschauung**

3749

VITALISM^{1) - 3) - 5)}

"The theory that life is maintained by some special force that cannot be explained by the principles of physics and chemistry" (J.Z. YOUNG, 1974, p.300).

As noted by YOUNG, this theory was closely related to DRIESCH's **entelechy**.

It was a purely verbalist pseudo-explanation, but it had the merit to consider living beings specificity and to trigger a controversy which led in a first step to BERTALANFFY and WOODGER's **organicism**, and from there to the concept of system, which emphasized the importance of internal **interrelations** and **organization**.

Later on, MATURANA and VARELA's **organizational closure**, and EIGEN's **Hypercycle** introduced a clearer explanation for the **maintenance** of **organization** in living systems. On the other hand, PRIGOGINE showed that a correct extension of **thermodynamics** to **open systems**, especially those faraway from **equilibrium**, could constitute a physical explanation of the **evolution** of life.

3750

VOLITION³⁾

"Conscious **purposeful behavior**" (M. BUNGE, 1979, p.172).

BUNGE enounces a systemic viewpoint about volition: "The will is not an entity but a **neural activity**... Nor is the will a mysterious faculty of an immaterial **mind**, but a capacity of highly evolved Central Nervous Systems, namely a control of **behavior** by the thought **process**" (1979, p.173).

Of course, BUNGE considers thought itself as an **activity** of the Central Nervous System.

It is interesting to compare these views with P. VENDRYES' and on the other hand H. MATURANA and F. VARELA's concepts of **autonomy**.

3751

VOLUTION ²⁾

A turn or twist about a center or a spiral, within a **whirl** or a **vortex**.

This is a characteristic feature of **toroids**, as a general systemic **model** proposed by D. Mc NEIL (1993,a,b), who writes: "The combined effect of systemic **order** and repeatability is to produce a **loop** or **cycle** of an ordering, i.e. a **voluntary organization**" (1993 b, p.5).

Still more generally, a volution is the materialized expression of **energy transfers** in a **field**.

3752

VON NEUMANN ARCHITECTURE ²⁾

The **set** of basic concepts for sequential **data** processing.

Practically all **data** processing machines are still based on the following principles, proposed initially by J.von NEUMANN:

- a central processing unit
- a store of **data** that must be at the disposal of the central processing unit
- a **set** of instructions (or **program**) that can be applied to **data** in order to obtain certain predefined results, within the limits of the **content** of the **program**.

This is a purely **algorithmic** concept: The machine is enabled to do anything that is programmed, within the limits of the existing **data**, but cannot do anything else. In particular, it cannot **learn** anything.

The new **connection machines**, based on **parallel distributed processing** through small individual units, on the contrary, may learn by using **rules**.

3753

VORTEX ^{1) - 2)}

A **flow** rotating about an axis within some **medium** which acts as an **environment**.

Vortices may appear in the most different types of fluids: stars clustered in spiral galaxies, planetary atmospheres (cyclones, hurricanes, typhons), oceanic waters, glaciers, rivers, vegetal and animal tissues, etc...

The French engineer Ch. LAVILLE devoted a book to vortices and wrote: "Whirling **flows** are **trajectories** along lines of least resistance. This implies that they condition the duration possibilities of a **phenomenon**".

"Vortices appear as **phenomena** limited in **time** and **space**: they arise, they grow, they go through a period of **dynamic stability**, they decline and disappear". Even so, they may frequently remain **dynamically stable** for a long duration.

"The **emergence** of a vortex is submitted to two conditions: an adequate **environment**, fluid by necessity (gaseous, liquid or finely divided solid) and a certain **heterogeneity** in this **environment**. In fact, all vortices arise from a movement of tangential opposition upon a mass in **translation**, thus creating a gyratory movement. Vortices thus result of the conjugated action of the central force that produced the **translation** and a couple creating the gyration; in other words, *they are determined by a dissymmetry* and, in their initial **phase**, they appear as a coil in the fluid mass"...

"The composition of both movements, **translation** and gyration, that characterizes the vortex, produces closed helicoidal lines developing around a central axis, thus materializing brachystochrone (i.e. of shortest duration in time) **trajectories**"...

"The vortex, in synthesis becomes individualized within the amorphous mass, of which it separated to take its **form**. To reach to this shape, it conforms to the following condition: The **structural set** of its current or tension lines communicates its resistance to oppose its deformation or destructure by the **environment**" (1950, p.52-54).

These characteristics clearly show that all complex systems are in a sense stationary vortices of structuring **energy**.

The vortex model is quite important for the understanding of the genesis of systems. It relates to the following complex phenomena:

- the basic **symmetry-breakings**
- the resulting **instabilities of energy flows**
- the **energy-matter** equivalence
- the **process-structure interrelations**
- the genesis and **transformation of forms**

See for instance d'ARCY WENTWORTH THOMPSON book "On growth and form" (1916).

LAVILLE made moreover these interesting comments:

- Vortices are minimum resistance **trajectories** and, consequently condition the possibility of duration of a **phenomenon**.
- Vortices as **phenomena** are limited in **space** and **time**: they arise, grow, attain **dynamic stability** for some time, until they decline and disappear.
- A vortex separates from its **environment** and acquires an **identity**

- As its **field** communicates it a resistance to external **disturbance**, it becomes a more or less durable **organization**. (Ibid)

This last point offers an interesting insight into the very basic and general nature of **auto-poiesis** and **organizational closure models**.

→ **Fields (Interaction between)**

3754

VORTEX (Stationary) ²⁾

A **vortex** which maintains unchanged its rotation rate (R. ROBERT & J. SOMMERIA, 1992, p.947).

This is the state of **dynamic equilibrium** of a **self-reproducing** vortex within a sufficiently stable **environment**.

The **analogy** with the concept of **organizational closure** seems obvious.

3755

VORTEX (Sub-dividing) ^{1) - 2)}

Ch. LAVILLE observed that any vortex may, under specific conditions, generate smaller vortices. He writes: "We may witness either a conjunction of separate vortices into a unique one, or the disjunction of one vortex into various individual ones" (1950, p.55).

As to the subdivision **process** he states: "The volume of a vortex does not seem to be able to exceed a certain **limit** depending on the conditions of its formation. Over this **threshold** it maintains the **coherence** needed for its **survival** by fractioning into smaller vortices" (Ibid)

Each of these corresponds to a **limit cycle**.

This **process** of production of vortices within vortices, etc... seems to be a very important factor of internal diversification, closely related to the construction of **complex systems** through subdivision and qualitative **differentiation of channels of energy flows**.

It would be interesting to try to connect the study of subdividing vortices with **fractals** theory and **deterministic chaos**.

→ **See also: Fields within fields**

In some cases, small vortices also can combine and construct a greater one at a higher **level of integration**, as shown by A.P. INGERSOLL's models of Jovian vortices (quoted by J. BRIGGS and F.D. PEAT, 1991, p.125).

3756

VORTICITY ²⁾

The local rotation **rate** in a whirling **flow** or **vortex** (R. ROBERT & J. SOMMERIA, 1992, p.947).

3757

VORTICITY CURVE (Iso-) ²⁾

"A curve which delimits a **zone** of equal rotation in a **vortex**" (R. ROBERT & J. SOMMERIA, 1992, p.947).

W

3758

WARNING (Early)¹⁾

Any **symptom** of probable **change** that can only be observed and understood within a systemic **framework**

Early warnings offer some **predictability** in **nonlinear systems**, even if within **limits**.

Predictability in **linear processes** is theoretically reliable. However, **linear processes** are exceptional and generally quite **unstable** in **time**.

Nonlinear systems are submitted to different **short, median and long term trends**, which are imbricated and mutually **constraining**. **Long term trends** are difficult to discover, because the needed **data** must cover a **span** that easily exceeds the professional life of a scientist, or manager, and even the accumulated historical **information**. Examples are **long term** reversals in stock markets; the movement of geological faults; multisecular mega-floods in river basins, etc.

However, **long term trends**, once established, constitute a more or less reliable frame for **median and short term oscillations**. This means that any strong or sudden **deviation** in these lesser **trends** probably heralds a reversal of the **phenomenon**, or **behavior** of the system, possibly in a **catastrophic** or **chaotic** way.

The development of a good general theory of early warnings could become a very significant contribution of systemics.

3759

WASTE^{1) - 4)}

Any unnecessary, useless, or nocive **output** of a system.

There are many different types of wastes. However most kinds can be classified as a useless **output** of either **matter**, or **energy** or **information**.

The sore point in the definition is the "useless" adjective. In many cases, it really means that we do not *see* any use for that specific **output**. In natural systems however, every **output** is finally recycled and again transformed into a **resource**, with the exception of *final residual heat*.

As to now, organic waste is generally recycled through biodegradation (but this process may take a long time and excesses of organic waste may asphyxiate some **ecosystems**). Inorganic waste, generally of artificial industrial and domestic origin, is mostly non-degradable, at least for an indefinitely long period, and tends thus to have these suffocating **side-effects**.

Many artificial wastes, produced by human systems, could possibly be recycled (and should be, whenever "practically" – another doubtful adjective – feasible).

A good general **understanding** of the various kinds of waste **flows** and their actual as well as possible alternative **circuits**, is the first step toward this end.

H.T. ODUM writes: "The cheapest way would be to use man's waste **flows** to stimulate the **circuits** of his interest" (1971, p.290).

He adds that, when various possibilities of recycling do exist, value decisions should be based on the most efficient use of **energy** (in **thermodynamic** terms).

Unfortunately, this still remain mostly wishful thinking because, in the words of E.J. KROWITZ: "How to measure **entropy** content; how to model the economic **transformation** in **entropy** terms, and measuring the environmental-**resource limits** all pose major obstacles to implement the concept" (1991, p.45).

3760

WAVE^{1) - 2)}**A periodic oscillation.**

There are many classes of waves. A. BOGDANOV considers waves as "... the most widespread method in nature of preserving or restoring **equilibria**". Moreover "This is a kind of general **model** for innumerable **processes** of the inorganic universe... But this **model** is also applicable without limit to the realm of life: almost all of the life **processes** are of the **periodic oscillation** type" (1980, p.9).

However, even in this sense, waves seem to ride on more generic **long term trends**. E. JANTSCH, for instance, writes about "waves of **organization** (which) may be understood as another manifestation, at a **macrolevel**, of the basic evolutionary mechanism of "**order through fluctuations**", of a **rhythm** alternating between **stabilization** and **mutation**, as it has been described for **nonequilibrium** physical systems". (1975, p.253).

N. ELDEREDGE and S. GOULD's model of punctuated (i.e. by periodic waves) **evolution** looks like another example of waves riding a more fundamental **trend** (1972, p.82-115).

3761

WAVE and TIDE MODEL¹⁾

A metaphoric **model** of the superposition of shorter and longer **cyclical oscillations**.

This **metaphor** was introduced by E. HERRSCHER (1989) and is quite useful for transmitting the understanding of the **interrelations** and interferences between **oscillations** of different **periods** and **amplitude**.

3762

WAVE Cycle (Long)

→ Cycle

3763

WAVE (Stationary)²⁾

A stable **periodic** regime of **oscillations**.

Various collaborators of PRIGOGINE, members of the so-called Brussels School, experimenting with chemical systems (for example the **BELOUSOV – ZHABOTINSKY** reaction: the oxydation of malonic acid by potassium bromate, in presence of cerium ions), discovered "... The existence of a stable **periodic regime** which corresponds to the alternation of a rapid **phase** of chemical waves propagating toward the center and a slow **phase** tending to homogenize the system" (G. NICOLIS & I. PRIGOGINE, 1977, p.100).

Stationary waves are closely related to **dissipative structuration**. They maintain themselves as long as the system remains **nonlinear**.

It would be quite interesting to research stationary waves in biological and **social systems**
→ **Soliton**

3764

WAVES (ELLIOTT'S)→ **ELLIOTT'S waves**

3765

WEAR¹⁾

The gradual impairment of a device or system.

Wear is a universal **phenomenon** in natural as well as in artificial systems, obviously connected with **entropy's** increase. P. WINIWARTER and C. CEMPEL, who investigated wear, define the following aspects of the wear problem:

- Wear leads timely to the destruction of the system. In natural system "wear causes death". In artificial ones, it leads to **break-down**.
- "Wear amplifies wear, a **positive feedback** leading to **autocatalytic** or **nonlinear behavior**".
- It is possible to define the notion of **break-down time**, which "is determined by the internal **structure** of the system and the way of **energy dissipation** inside the system".
- Systems have a "**life curve**", reflecting the wear **process**. It can be more or less defined and used for "**diagnosis** and **prognosis**" (1992, p.23-26).

3766

WEB¹⁾

Practically a synonym for **network**.

3767

WEBS (Multilevel)²⁾³⁾

"A class of systems in which various forces or **subsystems** interact **simultaneously** within and across **levels**". (C. HARDY, 2001, p. 35)

HARDY adds: "Webs thus exhibit dynamical **evolution** through the **cooperation** and **co-evolution of processes**" and...

"In multilevel webs, the **variety** and **complexity** of forces interacting simultaneously instantiate inter-influences between connected **elements/processes**, so complex that they render **causality** irrelevant as a **formalism**. Webs inter-influences are fundamentally **non deterministic**, and they reach beyond **causal mechanisms**".

"However, simpler mechanisms such as **linear cause-effects** and **circular causality** may exist as component processes, enmeshed in the ensemble of **interactions** of the more complex system"(Ibid.)

The crux of the matter is the **simultaneous** character of different **events** and **actions** at various **locations** in the system. As their **propagation** is generally neither **isochronous**, nor takes place in an **isotropic space**, rigorous **determinism** is impaired and replaced by statistical or **chaotic determinism**. It is however not suppressed, specially at **macroscopic scale**.

3768

WELTANSCHAUUNG^{1) - 3)}

A global paradigmatic **worldview**.

As observed by J. SUTHERLAND, any Weltanschauung "can not only serve as a guide for empirical efforts but (also) as a **perceptual filter** which can exclude **data** and causal **inferences** which would be incompatible within the context of the **paradigm** itself" (1973, p.121).

His/her Weltanschauung is the most global cultural **frame of reference** for the **observer**, who uses it and lives within it, many times without being conscious of it.

SUTHERLAND's comment actually refers to the **mechanistic** worldview, but it can be applied to *any* Weltanschauung, including of course the systemic-cybernetic one. Systemists should thus beware of conceptual absolutism and intolerance.

(Note: WELTANSCHAUUNG is a German word quite often used by some systemists, which is the reason for its inclusion in this encyclopedia).

Within the "archeology" of the concept, W.von HUMBOLDT's "Weltansicht"(World perspective) should be mentioned ("Gesammelte Schriften", Berlin Akademie, 1836-39)

3769

WELTANSCHAUUNG (Systems)¹⁾²⁾³⁾

As leit-motiv for the celebration of the 100th anniversary of Karl Ludwig von BERTALANFFY, Prof. ELOHIM (Technical University, Vienna) reproduced the following texts of this founder of the systems movement:

"The overall fate of the world depends on the adoption by humanity of a new **set of values**, based on a general systems Weltanschauung (worldview), and ...

(We must seek)" another basic outlook: the world as **organization**, (which) would profoundly change the **categories** of our thinking and influence our practical attitudes, as we must envision the **biosphere** as a **whole**- with mutually reinforcing or mutually destructive **interdependencies**"

In his introductory manifest for the celebration meeting at the Vienna Technological University- which took place in 2001- Prof. Elohim collected supporting or coincident opinions and views to BERTALANFFY's ones. Among these are notes and papers by Janet M. EATON, C.H. WADDINGTON, L. MUMFORD, R. HUTCHINGS, L. EISELEY, N. COUSINS and A. EINSTEIN.

(Personal communication from Prof. Elohim)

3770

WHITE BOX²⁾

"A system of known **components**, put together in a certain fashion so as to affect a given **input-output** functioning" (I. BLAUBERG & al, 1977, p.163).

In other words, it is any constructed **algorhythmic** device.

Consequently, the internal **mechanism** of a white box is apparent and understandable. Of course, this can be so for some **observers** and not for others, as distinct observers may produce different **descriptions** of the box, all of these mere results of their peculiar **position** as observers (R. GLANVILLE, 1979, p.35-7)

A simplistic observer may also see a **black box** as white, due to some superficial or **reductionist** way of observing. This can be very dangerous.

A possible example of this kind of simplifications is the dubious assimilation by some behavioral psychologists of man's **behavior** to a set of simple **input-output effects**. This can moreover easily lead to psychological manipulation, of the brain washing type.

Most man-made **machines** are, or at least, are intended to be white boxes. However, it frequently happens that the **components** and the way they are put together have unknown properties, which are not perceived at the time of assembly... and turn the white box into a **black box**.

3771

WHOLE^{1) - 2) - 3)}

A complete entity or system whose **components** or **elements** remain connected in a specific and globally functional way.

Wholes are no mere unstructured **aggregates**, devoid of any functionality. The basic regulating principle of coherent wholes is that every **behavior** of a **part** may influence (di-

rectly or indirectly) any other **part**. However, after a **time**, that can be very long, the global **process** may reproduce the **initial conditions**, or at least conditions very similar or equivalent.

In a whole, the **components** or **parts** become **immersed**, which means that some of their specific properties remain hidden, or become altered due to **interactions** with other **components** or **parts**. Good examples are the properties of hydrogen and oxygen atoms in water... or of a husband or father acting as an engineer in an enterprise, or vice-versa.

In G.S.T. the word "**holon**" (whose Greek origin is the same), proposed by J. SMUTS (1925, reprinted 1973), has been recovered by A. KOESTLER (1969) and is now quite incorporated within the systemic vocabulary, not however being uncontroversially admitted by all systemists. As the term "**Holon**" has been sometimes used in a careless way, "whole" is possibly a convenient substitute.

The concept of "whole" is also connected with the "**Gestalt**" one, basically in relation to our way of observing and perceiving.

3772

WHOLE and PARTS^{1) - 2) - 3)}

These antithetic concepts are very basic for the understanding of the systemic view of the world.

I. BLAUBERG, V. SADOVSKY and E. YUDIN, who consider both concepts as **categories**, write:

"The cleavage and opposition of the part and the whole produced the antinomies of **wholeness**. The principal ones were:

- 1. Thesis: the whole is the sum of parts Antithesis: the whole is greater than the sum of its parts (note: or less or other!)
- 2. The parts precede the whole. The whole precedes the parts
- 3. The whole is casually determined by its parts.

The **wholeness** approach is opposed to the causal one and rules it out

- 4. The whole is cognized through the **knowledge** of its parts

Parts as a product of division of the whole may be cognized only on the basis of the **knowledge** of the whole" (1977, p.99-100).

This traditional viewpoint has now been reformulated in a non contradictory way as stated by the same authors: "The solution of the problem lies in that **wholeness** is characterized by new qualities and properties not inherent in the parts but appearing from their **interaction** in a certain system of **connections**...

"... in the relation between the parts and the whole neither side can be considered without the other: a part outside the whole is not a part but quite a different **object**, since in an integral system the parts express the nature of the whole and acquire properties specific to it; on the other hand, the whole without (or before)

the parts is unthinkable, since an absolutely simple, structureless and even mentally indivisible body cannot have any properties or interact with other bodies" (1977, p.100).

Synthetically, a part (or **element**) within a whole (or system) is itself *plus* its **connections** with other parts and *less* the **constraints** which result from these **connections**.

As in many other cases, the old, absolute **di-chotomies** appear now as unduly simplified **abstractions**.

3773

WHOLE and PARTS relationship ¹⁾

W.R. ASHBY has established the following principle "That a whole dynamic system should be in **equilibrium** at a particular **state**, it is necessary and sufficient that each part should be in **equilibrium** at that **state**, in the conditions given to it by the other parts."

ASHBY comments: "Clearly, at any **state** of the whole, if a single part is not at **equilibrium** (even though the remainder are), this part will change, will provide new conditions for the other parts, will thus start them moving again, and will thus prevent that **state** from being one of **equilibrium** for the whole. As **equilibrium** of the whole requires that all the parts be in **equilibrium**, we can say (metaphorically) that every part has a power of veto over the states of **equilibrium** of the whole" (1960, p.79).

To take care of this aspect, R.L. ACKOFF proposes what could be called the architectural view: Essentially, no part can be changed (modified, increased, decreased, suppressed) without considering the impact of the **change** on the other parts and, if needed redesigning the whole (1995, p. 44).

While some **changes** of the parts may originate in **changes** of external **parameters** to the system, in this case this is left outside the picture.

From a new and significant viewpoint, wholes are now frequently considered **holo-graphic**. This implies that the whole is somehow reflected in every part. J.C. LUGAN offers curious insights in this sense: "Individual actors constitute society, but society, through the **socialization process**, is in each individual. Moreover, while society is produced by the **interactions** among its individuals, it retroacts by producing individuals through **education** and **language**" (1993, p.112).

In other words society tends to become **autopoietic**, by way of the scattering of its global characteristics among numerous individuals, just as if being an enormous **hologram**.

3774

WHOLE or SYSTEM or GESTALT ? ¹⁾

A. ANGVAL tried (in 1941!) to clarify in the following way the **meaning** of the word "whole": "The term "whole" is frequently used with a

very confusing double meaning. Sometimes the concrete organized **object**, other times the **organization** of the object is called a whole. The term is used in this latter connotation, for instance, when one states that a circle may be small or large, drawn in red or green color, and still remain the same whole, the same **Gestalt**. I propose that the term "whole" be reserved to designate the concrete **organized object** itself. The way of arrangement of **parts**, should be called system" (in F.E. EMERY, 1969, p.28).

After more than fifty years, the matter is not yet settled. Many authors *seem* to speak of "**concrete systems**", but J.L.LE MOIGNE considers that the system is a **model**.

In any case, it is of paramount importance never to confuse real **objects** (i.e., as we are able to perceive them), with conceptual **abstractions**.

3775

WHOLENESS ¹⁾

I. BLAUBERG, V. SADOVSKY and E. YUDIN describe the basic features of a system as a whole in the following way:

"1) The system is an integral complex of interconnected **elements**;

"2) it forms a special unity with the **environment** (in some problems the system cannot be considered in isolation from the **environment**, although this does not mean that all... problems of system and structural research are of this nature);

"3) usually any investigated system is an **element** of a higher-order system (that is, it may, in other problems, appear as a **subsystem** or **element** of a broader system);

"4) **elements** of any investigated system in their turn usually appear (again in special problems) as systems of a lower order" (1977, p.127).

The authors emphasize that "one must pay special attention to the **hierarchical** character of the system intimately connected with its wholeness. The **hierarchy** is manifested both in the chain of systems' inclusions into one another and in the **interaction** of individual **sub-systems**, including the character of the functioning of **goal-directed subsystems** and their impact upon the system concerned" (Ibid, p.127)

Thus the wholeness of the system implies the existence of **hierarchical** as well as **non-hierarchical** links.

Another aspect of wholeness is that "a variation of any **element** affects all other **elements** of the system and brings about a variation in the whole system, and vice-versa, variations of any **element** depend upon all other **elements** of the system" (Ibid, p.54).

The concept "expresses the **requeriment** for a special **description** of the system as a whole, different of that of its **elements** (non-additivity of the system as the sum of its **elements**) and

also the **intention** to oppose the system to its surroundings (the **environment**), the system's inner **activity** forming the base of the opposition" (Ibid, p.140).

J.A. GOGUEN and F.J. VARELA add some other interesting **viewpoints** about wholeness: "... it co-occurs with interesting **emergent** properties at some **level**. A sequence of notes is whole if it is an interesting melody. Similarly, the significant differences in **behavior** of cells and **organisms** from the **behavior** of atoms and molecules, marks the cells and **organisms** as whole systems".

"Another point of view toward wholeness, is that it can be measured by the **difficulty of reduction**: Because it is very hard to reduce the **behavior** of **organisms** to the **behaviors** of molecules, we may say that **organisms** are whole systems".

"A third point of view is that a system is whole to the extent that its **parts** are tightly **interconnected**, that is, to the degree that it is difficult to find a relatively independent **sub-system**".

"A fourth point of view is that a system seems more whole if it is more **complex**, that is more difficult to reduce to **descriptions** as **interconnections** of lower **level components**" (1979, p.41).

E. SCHWARZ observes that the need for making **distinctions**, which cannot be avoided, has on the other hand the negative effect, in classical scientific thought, to cut and even make disappear from our view, numerous significant **interrelations** among the **elements** and among the forces that dynamizes the **processes** (1999, p. 138-9)

This trend obviously started with DESCARTES "Discours de la Méthode"(1637)

→ **Distinction; Method (Discourse on the); Separability**

3776

WHOLENESS APPROACH ³⁾

I. BLAUBERG et al. also state that the requirements of the wholeness approach are "only seemingly simple to fulfil. In reality any complex problem must necessarily be decomposed into a **set** of subproblems each of which requires a special approach and, in particular, has an optimal solution all of its own. The point is, however, that *the optimal solution of the problem as a whole is not necessarily equal to the sum of the optimal solutions to its parts.*"

"... In other words, the entire intricate **hierarchy** of **operations** aimed at solving a complex problem must be organized in such a way that the chief and decisive **criterion** at all **levels** was a **unified evaluation** of effectivity, i.e. that the system as a **whole** and its ultimate effect should always be borne in mind" (1977, p.263).

The wholeness approach implies "the *fundamental irreducibility* of its properties to the sum of the properties of its **elements**, and the *non-deductibility* from the latter of the properties of the **whole**" (Ibid, p.269).

3777

WHOLENESS (The Paradox of)^{1) - 3)}

According to I. BLAUBERG, V. SADOVSKY and E. YUDIN: "It is impossible to cognize a system as a wholeness without "looking inside the system", i.e., without analyzing its **parts**" (1977, p.272).

Of course, the way we look inside the system is of capital significance. Instead of severing the internal **connections** between **subsystems** into **elements**, we use them as guidelines in our way of decomposing the system and never loose from sight the specific systemic **roles** of the **subsystems** and **elements**.

This is one of the basic tenets whose observance corresponds to the inverse **process**, i.e., reconstitution, which is the aim of **reconstructability analysis**.

3778

WHOLES (A logic of)^{2) - 3)}

In 1941, A. ANGYAL proposed a logic of wholes, as opposed to the logic of **relations** (but still complementary to it). He emphasized the inadequacy of the traditional logical tools for the study of complex **objects**, to which he already gave the name of "systems". He wrote, in particular: "A **relation** requires two, and only two members (relata) between which the **relation** is established. A complex **relation** can be analysed into pairs of relata, while the system cannot be thus analysed. A system may involve an unspecified number of members. A system is not a complex **relation**" (in F.E. EMERY, 1969, p.18).

He added however that there are "complex **connections** which are reducible to two-term **relations** on the one hand, and complex **connections** which cannot be (*thus*) reduced... on the other hand" and stated further on that "the type of **connections** in a whole is very different from the **connections** which exist in an **aggregate**" (Ibid, p.20).

ANGYAL expressly reserved the term "system" for "**holistic organization**"

ANGYAL views are reminiscent of RUSSELL and WHITEHEAD's **theory of types**. It is clear that the whole cannot be reduced to the "element" type, and that its relation to each element is of a different type, i.e. hierarchical (or "vertical") in opposition to "horizontal"

3779

WHOLES as Parts, parts as WHOLES^{1) - 2)}

Any system is part of the **environment** in which it is inserted and this **environment** is, from this viewpoint, a **supra-** or **metasystem**.

Conversely, any part of a system may generally be considered, in turn and at its own **level**, as a whole, within which parts can be identified.

FEIBLEMAN and FRIEND wrote: "**Subparts**, parts and wholes are the three **levels** necessary to constitute an **organization**" (1969, p.49).

Of course, there may be quite more than three **levels**, as shown in **living systems** by J.G. MILLER.

We should try to avoid a false **dichotomy** between parts and wholes. While, according to M. MARUYAMA, "There is no "whole" prior to parts" (1976, p.204), this author presents the "mutualistic view": "... there are only parts, and parts create a *system* of **interaction**" (Ibid).

3780

WHOLISM¹⁾

A near synonym for "**holism**", and even "systemism".

Some few authors use this word because "systems", "systemics", etc... are frequently associated with computer technology or **systems analysis**, or **systems engineering**. Such confusion obscures the deeper meaning of "wholism" as the specific global or wholesale approach to complex systems and/or **issues**.

As to "holism", it has now been kind of "hijacked" by an important group of practitioners of non main-line medicine.

Moreover, it has been sometimes unduly defined as antagonistic to **reductionism**, while of course both **methodologies** should be used in a complementary way, according to need. In fact, the multiplication of denominations for the **systemic approach** is confusing in itself.

3781

WICKED EFFECTS:

→ **Effects (Side)**

3782

WOBBLE²⁾

A unsteady **oscillation** of small **amplitude**.

One of the simplest "**catastrophes**", resulting from the **change** of a punctual **attractor** to a circular one.

3783

WORK FLOW^{1) - 2) - 4)}

A circuit linking successive steps in a complete **process**.

An example is to be found in the **process** of buying some commodity:

- consulting available **information**
- obtaining approval from technical and financial sectors;
- ordering the commodity;
- receiving and approving it;
- transmitting it to the sector in need for it and the corresponding **information** to accountancy.

Such flows are generally repetitive.

Workflows are analogous to **inputs** procurement, inside **transformations** and **outputs** in biological systems.

3784

WORK (Useful)¹⁾

The **activity** a system is able to exert on itself or on its **environment** in order to maintain its **dynamic stability** or to increase its **organization**.

The potential of the system for useful work depends on its already acquired internal **organization** and of the **thermodynamic** of its **equilibrium relation** with its **environment**

3785

WORKSHOP⁴⁾

"A teaching-training seminar which emphasizes free discussion and exchange of ideas along with principles, concepts, practical **methods**, and skills for **problem solving** and/or professional development" (UNEP - UNESCO, 1983, p.31).

In research on complex **situations** or **issues**, workshops are ideally **transdisciplinary** in order to produce a cross-fertilization among participants.

3786

WORLD ENGINE^{1) - 2)}

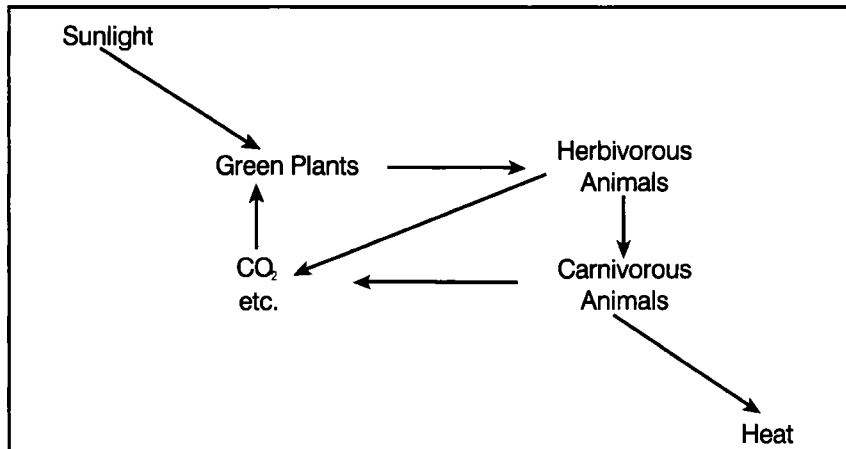
This striking concept, a forerunner of LOVELOCK's GAIA, was formulated as early as 1924 by A. LOTKA, who thus introduced the first ecological **model** of the planet as a globally connected system, as shown in figure (1956, p. 331).

see figure next page

LOTKA understood moreover that the world engine functions *cyclically*, and is a gigantic dissipator of **energy**. He added: "... in detail the engine is infinitely complex, and the main **cycle** contains within itself a maze of subsidiary **cycles**. And, since the **parts** of the engine are all interrelated, it may happen that the **output** of the great wheel is limited, or at least hampered, by the **performance** of one or more of the wheels within the wheel... If the working substance, or any ingredient of the working substance of any of the subsidiary **transformers**, reaches its **limits**, a **limit** may at the same time be set for the **performance** of the great **transformer** as a whole. Conversely, if any one

¹⁾general information ²⁾methodology or model ³⁾epistemology, ontology and semantics ⁴⁾human sciences ⁵⁾discipline oriented

Figure: see entry **WORLD ENGINE**



The World-Engine

From A. LOTKA: 1956, p. 334

of the subsidiary **transformers** develops a new **activity**, either by acquiring new **resources** of working substance, or by accelerating its **rate** of revolution, the **output** of the entire system may be reflexly stimulated" (Ibid).

This is LOTKA's Principle of selection for maximum power **output**, which refers to **eco-systems**, i.e. complex **networks** of **complex systems**.

LOTKA perceived clearly that the world engine undergoes a permanent **evolution** which improves it, through an increase of **complexity**.

The correlations with Prigoginian **thermodynamics** of **systems far away from equilibrium** and with BÉNARD's **dissipative structuration** are obvious.

3787

WORLD GOVERNANCE^{1,4)}

The rapid and complete **integration process** of a **world system** now ongoing introduces the issue of world governance. This is probably the most critical ever **issue** in the **evolution** of mankind.

The existence and possible use of massive destruction weapons implies the possibility of self annihilation of the human species, if not all life on this planet.

World governance is typically a mega-systemic matter

Every aspect of human life in relation to the natural **environment** as well as to the internal **organization** of human **groups** at every conceivable **level** must enter into the global **panorama** of the world governance issue.

The present world **situation** is a confused **network** of muddled **interactions** of multiple different kinds and, obviously, no single individual, nor group could even dream of understanding this **whole** in any detail.

The only basic feature is that multiple and dangerous contradictions are present in every domain we can think of. Only one basic idea seems clear; we (i.e. the six billions inhabitants

of the planet) must harmonize our **symbiosis** with our planetarian **Mitwelt** (**environment**) and eliminate the dangerous and sometimes murderous disfunctionalities, oppositions and misunderstandings that lead everyday to thousands of premature deaths.

Our problem is at first a matter of **understanding** in systemic terms of the conditions that would lead to our demise or **survival**. Secondly, we must find out how we could avoid the first and secure the second. This is also a matter of cybernetic and systemic understanding.

And finally, if not all, at least a considerable majority of people should seek **consensus** through **conversation** and assume their own **responsibility** in practical **action**. The growing number of groups and institutions (governmental or primary) that are reaching **consciousness** of evermore numerous aspects of the global issues shows that we are on our way. But it is a race against time.

In this sense systemic and cybernetic research is much more than an academic topic and could finally become a decisive global life saver. It could provide us with **tools** for understanding and the **education** and **training** of better helmsmen.

→ **Evolutionary learning communities;**
Syntony Quest

3788

WORLD HOMEOSTAT SYSTEM (WHS)¹⁾

"A central **guidance** system operating within the world system and regulating its **functional states**" (E. LASZLO, 1974, p.148).

This is a model of a global **regulator** proposed by E. LASZLO. It reminds of FORRESTER's **World Dynamics**, which is in a sense, an intent to create a **world model**, obviously the first step toward LASZLO's WHS. However, the controversies aroused by the **Club of Rome world models** showed that the proposal is not simple.

LASZLO's idea also reminds of LOVELOCK's **Gaia concept**, wherein the **guidance** is *intrinsic* to the **ecosphere** itself.

3789

WORLD MODELS^{1) - 5)}

Very global models aiming at **forecasts** of planetary long term **trends** in demography, ecology, economy and social evolution.

Around 1970, the **Club of Rome**, using J. FORRESTER's **systems dynamics** in its most general form ("World Dynamics"), started a series of world models, which were heavily criticized for methodological, ideological and socio-political reasons.

Already in 1974, E. LASZLO stated: "Because the world is a highly heterogeneous system, with multiple **hierarchic levels** and a large number of **relevant variables**, constructing a detailed global **structure** is a colossal task" (1974, p.124). So it indeed proved to be.

As to the **methodology**, and in a very general frame, G. KLIR writes: "As a rule, genuine systems problems are computationally extremely difficult. They are often made tractable by overly strong simplifying assumptions that are usually not stated. The resulting **methods** can then deal with sizable systems emerging from practical applications and produce "impressive" results, but the significance of these results is questionable at best" (1993, p.50).

The relative failure of world models somewhat discredited systems views in general and G. KLIR thus adds: "Such methodological dishonesty is contrary to the spirit of **systems science**. The latter is not interested in producing immediately marketable methodological tools at the cost of convenient simplifying assumptions whose validity is dubious, but rather in pursuing basic methodological research involving genuine systems problems" (Ibid).

3790

WORLD ORGANIZATION OF SYSTEMS AND CYBERNETICS (WOSC)¹⁾

This Organization was created in the 1960's by the British cybernetist Prof. J. ROSE. It publishes since 1971 the Journal "Kybernetes". It organizes every three years an International Congress of Systems and Cybernetics.

Prof. St. BEER was President of the WOSC until his untimely disappearance in 2003.

Prof. R. VALLEE (Université Paris-Nord, France) is the General Director of the Organization and maintains its presence in Europe

3791

WORLD (Small)

→ **Small world**

3792

WORLD (Surrogate)

→ Surrogate world

3793

WORLD SYSTEM¹⁾²⁾⁴⁾

A global **model** of the **man-planet system** in the making.

Such a model, which may become an absolutely need for mankind **survival**, does not yet exist.

It should integrate all and every aspect of human existence as related to the planetary **environment** (*Mitwelt, Umwelt*) and to social **organization** in the widest all-embracing sense.

Systemics and Cybernetics appearance between 1948 and 1960 are probably a kind of immunological reaction of mankind confronted with a growing danger of self-annihilation.

The new models of **processes** and ways of organization that thus emerged are doubtless first rate and indispensable **tools** for global **understanding** and- hopefully- satisfactory **management** of the world system model to be elaborated.

As an example- still specific, but already wide-reaching- of such a possible model, the Slovenian work on "**System thinking** and climate change system" (T. ECIMOVIC, M. MULEJ, et al., 2002) is an outstanding effort.

3794

WORLDVIEW

Because of its frequent use by some systemists the German word **Weltanschauung**, equivalent to worldview has been adopted, at least in some cases.

→ **Weltanschauung**

3795

WU-LI, SHI-LI, REN-LI (WSR): an Oriental Approach to Systems¹⁾⁴⁾

The following note is merely a too short summary of a very significant and original development taking place mainly in China.

GU Jifa and ZHU Zhichang write: "Chinese philosophy since the ancient times has been characterised by its belief and intention towards integration, harmony and holism. The three major ancient Chinese philosophical traditions (Buddhism, Taoism, and Confucianism) all emphasize harmony e.g., the unity of TIEN (objective existence), TAO (mechanism of the Universe) and REN (human intention); the unity of YIN (negative, lunar, feminine, soft, etc) and YANG (positive, solar, masculine, hard, etc); the unity of ZHI (knowing) and XING (doing), etc. All of these believe that human beings simultaneously understand and create the world., Therefore the life world of human conception, intention and action, cannot be properly investigated and researched as if separated from their sur-

roundings. The philosophies also suggest that the TAO (moral), ZHI (knowledge), and XING (action) of human beings are systematically related to the conditioning and support of one another, and therefore cannot be "artificially" isolated from one another" (1995, p. 31)

The authors also explain the Chinese medical notion of QI: "...all organic parts and sub-systems in a human body are integrated by QI. QI has no physical form. Nor is it a type of object matter. Yet it has effects like an electronic or magnetic field. It is QI that co-ordinates interactive performances through-out all parts of the human body. Subsequently problems in one part of the body may find their behavioral causes in another part of the body, or in the environment. Compared with their Western counterparts, the Chinese uphold a cultural tradition which focuses more on GUANXI (relationships), which may be between members of a family, within or between organizations, and within society as a whole" (ibid, p. 32)

The authors present WSR in the following terms: "The philosophy underlying the WSR approach suggests that social situations are constituted by WU (objective existence) SHI (mechanisms of the universe), and REN (human intentions).

Therefore any project tackling such situations should consider all WU-LI, SHI-LI, and REN-LI elements in a holistic manner, although a single LI may manifest itself as dominant or a more urgent element than the others of certain stages" (ibid)

In a graphical representation the authors consider:

WU-LI (Objective existence) as the subject of knowing and studying
SHI-LI (Mechanisms of the universe) as being in need of understanding and modelling)
REN-LI (Human relations) as in need of co-ordination and compromise

WSR also presents dynamical aspects that the authors represent in a closed circle:

- understanding desires
- investigating conditions
- formulating objectives
- creating models
- co-ordinating relations
- implementing proposals

...and back to understanding desires.

The similarity with WARFIELD's generic design or FLOOD's and JACKSON's Total Systems Intervention seems obvious.

Finally, the authors state that "the WSR process should not be read as a step-by-step Chinese "cookbook", (but) rather it should be tailored by participants in accordance with their situational requirements" (p. 37) and give examples of the practice of WSR.

For more information, see also PRESSMAN, T.E. (1992)

Y

3796

YIELD¹⁾

The **output** of a system, usable by other systems.

Obviously, as the system depends of its **environment** for its **inputs**, yields are generally variable with environmental conditions. **Variations** may be more or less **cyclical** in an intricate way, depending on the **interrelations** of the system with other ones, which may be its competitors for **inputs**.

Yields in ecological systems have been studied by V. VOLTERRA, A. LOTKA, H.T. ODUM and many others.

In very complex **ecosystems**, not perturbed by man, yields of the different species tend to vary only slightly. According to H.T. ODUM: "If the yield is not taken, the stocks and system **structure** develop" (1983, p.93). Of course, there are **limits** to this development.

ODUM moreover states: "There is an optimum removal **rate** that optimizes the stock to its **energy input** with the maximum steady drain of the yield. This is called the optimum catch" (ibid).

3797

YIELD (Maximum sustainable)^{1) - 4) - 5)}

The concept of maximum sustainable yield is generally **equilibrium-centered**, i.e. based on the postulate that the **population** or system considered merely fluctuates between permanently stable **limits**, which will not be crossed.

However, as stated by C.S. HOLLING: "An **equilibrium-centered** view is essentially static and provides little insight into the **transient behavior** of systems that are not near the **equilibrium**. Natural, undisturbed systems are likely to be continually in a transient **state**; they will be equally so under the influence of man. As man's number and economic demands increase, his use of **resources** shifts **equilibrium states** and moves **populations** away from **equilibria**" (1976, p.73).

No vegetal, animal or human **population** exists isolated from its **environment**, partially made of other species. Thus, some **disturbance** affecting an apparently unrelated system, may well in due **time** propagate itself to the **population** under research. And it could do so in unforeseen ways, triggering wide **divergences** from the former **equilibrium**. It may for example lead the **population** under review to cross an **instability threshold** and, as a result, introduce **bifurcations** and a **chaotic behavior**. This explains why, for instance, overfishing of one species, followed by a **population** crash, may lead to a permanently depleted **population**: the global **equilibrium** has been permanently altered in a way detrimental to the species under focus.

Such **situations** start now to appear in widely different systems under the pressure of massive abuse by man.

Z

3798

ZEITGEIST¹⁾⁴⁾

"The dominant set of **concepts**, opinion and prejudices proper to some **culture** during a historical **period**"

The meaning of this german word is "the Spirit of the time"

An example would be the set of Victorian values and their practical translation in everyday life.

The concept was developed by HEGEL in the 19th Century, along with the concept of "**Weltanschauung**".

3799

ZERO GROWTH^{1) - 2) - 4)}

An hypothesis purporting the possibility for **human systems** to reach a **steady state**, or **dynamic stability** after a **period** of **exponential** or **logistic growth**.

Such hypotesis can be applied to **populations**, industrial sectors, economic **development**, or **human ecosystems**. It was very widespread, and controverted, during the seventies.

The general conditions of systems **growth** seem to support the hypothesis. However, a **steady state** could be reached after very different **growth** curves, from a smooth **logistic asymptote** to dramatic crashes after more or less considerable **overshoot** resulting from exponential growth.

Moreover, there is a wide variety of **human systems** at different stages of **growth** and their evolution is not synchronized. As a result, rivalries do appear and become a source of economic, political and even ideological struggle, which completely obscures the **issue**, specially in absence of any **systemic understanding**.

3800

ZERO POINT²⁾

The place where, or moment when a system is in a neutral **state**.

This point corresponds to the **situation** in which the system obtains no advantage, nor suffers any adverse effect.

3801

ZERO-CROSSING²⁾⁵⁾

"The place where the value of a **function** passes from positive to negative, or vice versa" (M. BODEN, 1988, p.60)

3802

ZERO-SYSTEM^{1) - 2)}

"A system of **components** that has not developed **functions** yet" (V. CSANYI, 1993, p.263).

CSANYI develops as follows this very important and not yet widely known concept, which gives a clearer understanding of **autogenesis**:

"A zero-system has no **organization**. A precondition for starting a **self-organizing process** in a zero-system is the presence of a minimal **set of components** which is able to replicate and which fulfills the following **criteria**:

"1. It contains at least one **cycle of component-producing processes**;

"2. At least one of the **components** participating in this **cycle** can be excited by the **energy flux** flowing through the system" (Ibid).

CSANYI calls such minimal sets of **components** "**autogenetic system precursors**" (AGSP)".

3803

ZEUGMA¹⁾⁵⁾

A greek word whose **meaning** is **link**, **connection**. It has been introduced by the Greek psychiatrist and systemist N. PARITSIS in his study of **psychological contexts**. (2000)

3804

ZIPF LAW^{1) - 2)}

A numeric **correlation** between the **frequency** of occurrence of different words in a **language**.

Zipf showed that the most common word ("the" in English) occurs 10 times more than the 10th more common word, 100 times more often than the 100th most common word, and so forth.

This intriguing feature seems to be a quite general property, probably correlated to **fractals** and **renormalization** properties.

Recently, some genetists found that non-coding DNA (so called "junk" DNA) follows the ZIPF relation, i.e. has the **structure** of a **language** (Ph. YAM, Scientific American. vol 272, 3, 1995)

Zipf Law is obviously a **power law**, as it applies to the same general type of **phenomena**, for instance in the use of words in a **language**, or in the number of cities as ranked by their **population**. It reflects a collective property emerging from a statistical **behavior** or **relation** among numerous **elements** of similar individual characteristics within a **class** or a **region**.

3805

ZONE of ACTIVITY^{1) - 4)}

Part of the **environment** where a system is capable to exert some **action** (A. LOTKA, 1956, p.344-5).

This concept, can be applied to all living and meta-living **systems**, if one understands by **action** the product of a **correlation** device between the system and its **environment**.

For some physical systems, as for example planetary systems or stellar ones, the **correlation** exists and also defines a zone of activity. However, this zone is a **field**, more or less diffuse and it could be spoken of **receptors**, **elaborators** and **effectors** without semantic misuse.

LOTKA emits some interesting comments:

1. The systems **behavior** can be deeply modified and eventually polarized if a new **element** or factor is introduced in its zone of activity;
2. The dimensions of this zone may be modified if the system increases or reduces somehow its **perception** or action's ability;
3. There is an important difference, within the zone of activity between merely reactive **behaviors** and duly planned ones;
4. The zones of activity of two or more interactive systems are not necessarily symmetrical, nor fully superposed.

LOTKA distinguishes a "zone of influence" and a "zone of mobility". The second one does not necessarily includes the whole of the former one. LOTKA gives the interesting example of the constellations used by a seafarer to orient himself, but on which he has no power whatsoever. Or, in human societies, the influences that an individual receives are *generally* quite more important than those he is himself capable to exert.

3806

ZOOIDS¹⁾²⁾⁴⁾

The small individual **organisms** that compose **colonial** ones.

Some examples are the amoebae that constitute the collective form of the slime mould **Dictyostelium discoideum**; or the thousands of small animals that compose the Portuguese man-of-war (Physalia).

It is in fact their **integration** in a functional individual on a higher **level** of **complexity** at which they interact in new emerging specific ways which differentiate the zooids from similar **elements** in a more **autonomous** condition.

The extensive use of the term has been sometimes criticized. However, each **organism** is in fact a collectivity, whether of **cells**, or of more complex individuals, as in a beehive or a **swarm** of ants...or human societies.

At the **living systems level**, zooids are similar to particles in atoms, atoms in simple or more complex molecules and organic molecules as living matter **components**.

3807

ZOOSEMIOTICS¹⁾⁴⁾⁵⁾

The study of **signs** in the **communication** between animals (T.A. SEBEOK, 1972)

This study has been since that time abundantly fertilized by studies in animal psychology in the field and in laboratory (J. GOODALL, FR.DE WAAL, etc.)

APPENDIX

BIBLIOGRAPHY

A complete bibliography of Cybernetics and Systems would be a considerable work in itself. The following list should be considered merely as a partial one. It is moreover centered on the literature that has been used in this Encyclopedia. In any case, it is believed that no basic works have been ignored.

The bibliography contains a significative number of references in languages other than English (Dutch, French, German, Italian, Spanish, and others), which will be useful for researchers in some countries without any easy access to literature in English.

Many of the items enumerated have been directly used in the Encyclopedia as indicated under the respective entries.

Nearly all the others have at least influenced on the work.

The following basic collections should be widely consulted for wider reference.

Institutions

Association MCX Programme Européen de Modelisation de la Complexité Université d' Aix- en- Provence
www.mcxapc.org

CIRET
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GES- Group d' études systémiques de Tunisie
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MIT: Massachusetts Institute of Technology
www.mit.edu/

Open University, United Kingdom
www.open.ac.uk/

Swiss System Society (Neuchâtel University, Switzerland)
www.unine.ch/

Union Européenne de Systémique
www.afscet.asso.fr/ues

World Organization of Systems and Cybernetics (WOSC), Paris
ava.univ-savoie.fr/

Some informal Groups also exist in Chile, Colombia and Venezuela

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Abbreviations of Titles

Acad. Manag. J.: Academy of Management Journal
Acad.Manag. Rev.: The Academy of Management Review

Adm.Sc.Quarterly.: Administrative Sciences Quarterly
Adv. Syst. Res. & Cyb.: Advances in Systems Research and Cybernetics

Amer. Behav. Sc.: American Behavioral Scientist

Amer.Math.Monthly: American Mathematical Monthly

Amer. Natur.: American Naturalist

Amer. Psychol.: American Psychologist

Amer. Sc.: American Scientist

Ann. Hum. Gen.: Annals of Human Genetics

Artif. Intell.: Artificial Intelligence

ASC Forum: American Society of Cybernetics Forum

Behav. Science: Behavioral Science

Bell Syst. Tech. J.: Bell Systems Technical Journal

Biophys. J.: Biophysical Journal

BJPS : British Journal for the Philosophy of Science

Bull.Math.Biophys.: Bulletin of Mathematics and Biophysics

CASYS J.: Journal of the Chaos Society, Institute of Mathematics, Univ. of Liège, Belgium

Center Stud.Stat.Mech.&Ther.: Center Studies of Statistical Mechanics & Thermodynamics

Comm. Math.Phys.: Communications on Mathematical Physics

Curr.Anthrop.: Current Anthropology

Cyb. Forum: Cybernetic Forum

C&HK: Cybernetics and Human Knowing

C&S : Cybernetics and Systems

Deut.Zeit. Phil.: Deutsche Zeitschrift für Philosophie

Educat. Technol.: Educational Technology

Europ.J. Oper. Res.: European Journal of Operational Research

Gen. Seman. Bull.: General Semantics Bulletin

Gen. Syst. Bull.: General Systems Bulletin

General Systems Yearbook

Hum. Biology: Human Biology

Hum. Relat.: Human Relations

Hum. Syst. Manag.: Human Systems Management

IDIMT: Interdisciplinary Information Management Talks (Ann. In Zadov, Czech. Rep.)

IEEE Trans. Syst. Manag. Cyb.: IEEE Transactions on Systems Management & Cybernetics

IFSR Bulletin: International Federation of Systems Research Bulletin

IFSR Newsletter: International Federation of Systems Research

I.J.G.S.: International Journal of General Systems
 J.Appl.Syst.Anal.: Journal of Applied Systems Analysis
 IMC Transactions: Transactions of the Institute of Measurement and Control
 ISGSR International Society for General Systems Research Yearbook
 ISI: International Systems Institute (Pacific Grove, San Francisco, USA)
 Inf. & Contr.: Information and Control
 Inf. Proc. Machines: Information Processing Machines
 Inf. Sc.: Information Science
 Internat.J. Approx. Reas.: International Journal of Approximate Reasoning
 Internat.J.Man-Mach.Stud.: International Journal on Man-Machines Studies
 Internat.J. Syst. Sc.: International Journal of Systems Science
 Internat.Syst. Science Hand: International Systems Science Handbook
 J. Amer. Inst. Plann.: Journal of the American Institute of Planners
 J. Amer. Soc. Inf. Sc.: Journal of the American Society of Information Science
 J. Appl. Syst. Analysis: Journal of Applied Systems Analysis
 J. Biol. Syst.: Journal of Biological Systems
 J. Gen. Systems: Journal of General Systems
 J.Interd.Econ.: Journal of Interdisciplinary Economics
 J. Cyb.: Journal of Cybernetics
 J. of Ideas: Journal of Ideas
 J. Math. Anal. & Appl.: Journal of Analysis and Applications
 J. Phil. Sc.: Journal of the Philosophy of Sciences
 J. Soc. & Biol.Struct.: Journal of Social and Biological Structures
 J. Syst. Eng.: Journal of Systems Engineering
 J. Theor. Biology: Journal of Theoretical Biology
 Manag. Sc.: Management Science
 NATO Conf. Appl.Gen.Syst.Res.: NATO Conferences Applied General Systems Research
 NATO Panel Org. Res.: NATO Panel on Organization Research
 N.Sc.: New Scientist
 Notre Dame J.Form.Log.: Notre Dame Journal of Formal Logic
 Phil. Soc. Sc.: Philosophy of Social Sciences
 Phil. Trans. A: Philosophical Transactions "A"
 Phil.Trans.Royal Society: Philosophical Transactions of the Royal Society of London
 Phys.Bull.: Physics Bulletin
 Phys. Rev.: Physical Review
 Phys. Rev. Lett.: Physical Review Letters
 Psychol. Rev.: Psychological Review
 Proceed. Cyb. Soc.: Proceedings of the Cybernetic Society
 Proceed. ISSS Meeting: Proceedings of the International Society of Systems Sciences
 Proceed. Universitätverlag R. Trauner: Proceedings University Rudolf Trauner, Linz, Austria
 Quart.Rev.of Biophys.: Quarterly Review of Biophysics
 Rev. Biomat.: Revue de Biomathématique

Rev. Internac. Sist.: Revista Internacional de Sistemas (España)
 Rev. Internat. Systémique: Revue Internationale de Systémique
 Robot & Autom. Syst.: Robot and Automatic Systems
 Sc.Amer.: Scientific American
 SGSR Yearbook: Society for General Systems Research Yearbook
 SPAR: Systems Practice & Action Research
 SRBVS: Systems Research & Behavioral Science
 Syst. Dyn. Rev.: Systems Dynamics Review
 Syst. Pract.: Systems Practice
 Syst. Research: Systems Research
 Syst. Sc.: Systems Sciences
 Syst. Think.: Systems Thinking
 Systems, Wroclaw: Journal of Transdisciplinary Systems Sciences- Wroclaw University, Poland
 UNU: United Nations University

Journals

* Sponsored by the International Federation for Systems Research (Secr. Gehrard CHROUST, Univ. of Linz, Austria, who also publish a quarterly Newsletter of the IFSR)

(): number of issues per year

Analyse de Systèmes(4), published since 1974 under the direction of J. P. ALGOUD in Paris by the Groupe International de Formation et de Recherche en Théorie et Analyse de Systèmes

Behavioral Science (4)*, published since 1955 under the editorship of James G. MILLER in San Diego, CA, U.S.A. (discontinued end 1996, fused with Systems Research)

CASYS, published since 1998, edited by Institute of Mathematics, Univ. of Liège, Belgium, ed. Prof. Daniel DUBOIS

Cybernetica (4), published by the International Association of Cybernetics, Namur (Belgium), since 1956 (discontinued end 1998)

Cybernetics and Human Knowing (4), published since 1994 by Sören BRIER, Aalborg, Denmark

Cybernetics and Systems (6)*, since 1970, now edited by Robert TRAPPL, Austrian Society for Cybernetic Studies and published by Taylor and Francis, Bristol, Pennsylvania, U.S.A.

Human Systems Management (4), since 1981, under the editorship of Milan ZELENY, Fordham Univ. at Lincoln Center, New York.

International Journal of General Systems (4)*, since 1974, edited by George KLIR and published by Gordon & Breach

International Journal of Systems Science (12): since 1970. Current editors are J.C. HARRIS and Hugh DURRANT WHYTE of United Kingdom. The publisher is Taylor and Francis.

Journal of Cybernetics, published from 1970 on by the American Society for Cybernetics (Probably discontinued. Present status unknown)

Kybernetes (4), published by the World Organization for Systems and Cybernetics since 1972, whose editor is now Robert VALLÉE, currently in charge of the WOSC

Kybernetik, published in Germany during the 70's (present status unknown)

Newsletter Cybernetics Academy Odobleja (Ir), since 1983 in Milano, Italy (present status unknown)

Revista Internacional de Sistemas (4), since 1989 by the Sociedad Española de Sistemas Generales, under editorship of Rafael RODRIGUEZ DELGADO († 1997)

Revue Internationale de Systémique (4), since 1986, now under editorship of Bernard PAULRE, published by Dunod and Gauthier Villars, Paris, France (discontinued end 1998, substituted by www.res-systemica.org)

Sistemica (Ir), published since 1990, under the editorship of Ricardo RODRIGUEZ ULLOA, by Instituto Andino de Sistemas, Lima, Peru

Systemica (Ir.), since 1980, under the editorship of Gerard de ZEEUW et al., published by the Systeem Groep Nederland, Delft Univ. Press, Holland

Systemist (4), since 1978, under the editorship of Frank STOWELL, by the United Kingdom Systems Society, Nuffield Center, Portsmouth, U.K.

Systems Practice (6)*, since 1987, under the editorship of Robert FLOOD, published by Plenum Press, New York and London (discontinued end 1997, fused with Action Research)

Systems Practice and Action Research (6) published since 1998 by Kluwer-Plenum Press, editor Robert L. FLOOD

Systems Research (4)*, since 1984, now under editorship of Michael C. JACKSON, published by J. WILEY, New York and London.

Some few other journals on Systems and Cybernetics in general have appeared... and disappeared from 1955 on. It has not been possible to trace them recently.

A number of journals about Biocybernetics, Control systems, Fuzzy sets, Management and other more specialized fields do exist and have been occasionally mentioned in the bibliography.

"Behavioral Science" and "Systems Research" have been merged in 1997. The publisher is Wiley. (discontinued end 1996, fused with Behavioral Science)

Systems Research and Behavioral Science (6), published since 1997 by J. Wiley, editor Michael C. JACKSON

Proceedings

A considerable number of Proceedings of international and national meetings have been published since 1956 on.

They are unfortunately quite out of reach for anybody. In some cases they may even have disappeared. This is a pity, because these proceedings are an exceptional source of interesting - and even at times outstanding - material that cannot be found anywhere else.

The following have been consulted:

-IDIMT. Interdisciplinary Information Management Talks. These Proceedings of an Annual Meeting in Praga (Czech Republic, since 1998) are published by Universitätsverlag R. Trauner, Linz; 11 vols. published until 2003

- Proceedings of the Annual Meetings of the ISSS (formerly SGSR and ISSR): 40 meetings to date (probably more than 30.000 pages altogether!)

- **Proceedings of the bi-annual meetings of the Austrian Society for Cybernetic Studies**, Vienna, Austria (13 meetings to date, since 1972)

- **Proceedings of the tri-annual Congresses of the International Association of Cybernetics**, Namur, Belgium (Since 1956: 14 Congresses to date)

- **Proceedings of the European Congresses on Systems Science** (two Congresses since 1989)

- **Proceedings of some of the Baden Baden meetings** organized every two years by G. Lasker of Univ. of Windsor, Ontario Canada

The International Society for Systems Science published from 1956 until 1984, an excellent Yearbook, which unfortunately seems to have been discontinued. This collection was also widely consulted.

Occasional papers on Systems and Cybernetics have appeared in many other journals since 1952 and have been also quoted as widely as possible.

ABMA, T.(ed.): "Telling tales: on evolution and narratives"- JAY Press, Stanford, CT, 1999

ABRAHAM, Ralph: "Vibrations and the realization of form" in Jantsch, E. & Waddington, C. (eds.): "Evolution and Consciousness", Addison Wesley, New York, 1976

ABRAHAM, R. & SHAW, C.D.: "Dynamics: a visual introduction" in YATES, F.E. et al.(eds.): "Self organizing systems: the emergence of order", Plenum Press, New York, 1987

ABRAHAM, Ralph & SHAW, Christopher: "Dynamics, the Geometry of Behavior" - 4 Vol. - Aerial Press, Santa Cruz, CA, 1982-88

ABRAMOVITZ et al.: "Cybernetics of cybernetics". Biol. Comp. Lab., Univ of Illinois, Urbana, 1974

ABU, Mustafa Y.S: "Machines that learn from hints", Sc. Amer. 272 (4) 1995

ACAR, William: "Toward a consistent terminology for management theory building". Syst. Research, 4 (2) 1987

ACAR, William: "Theory versus Model". Syst. Research, 5 (2) 1988

ACHTERBERGH, J. & all.(eds.): "Organizational cybernetics"- Nijmegen Business School, Nijmegen, Netherlands, 1997

ACHTERBERGH, J. & VRIENS, D.: "Managing viable knowledge"- SRBVS, 19(3) 2002

ACKOFF, R.L.: "Games, decisions and organizations" SGSR Yearbook, 4, 1959

ACKOFF, R.L.: "Systems, organizations, and interdisciplinary research". SGSR Yearbook, 5, 1960

ACKOFF, R.L.: "Scientific method". Wiley, New York, 1962

ACKOFF, R.L.: "Towards a system of Systems concepts", in J. BEISHON & G. PETERS (eds): "Systems Behavior", Open Univ., Harper & Row, London, 1972. (From Manag. Sci., 17, Jul 11th 1971)

ACKOFF, R.L. & EMERY, F.E.: "On purposeful Systems", Aldine-Atherton, Chicago, 1972

ACKOFF, R.L.: "General Systems Theory and Systems Research", in Mesarovic, M.(ed.): "Views in G.S. Theory", Krieger Publ. Co., New York, 1974b

ACKOFF, R.L.: "Redesigning the future". Wiley, New York, 1974

ACKOFF, R.L.: "The system revolution". Long Range Planning, pp.2-20, 1974

ACKOFF, R.L.: "The art of problem solving". Wiley, New York, 1978

ACKOFF, Russell L.: "Creating the corporate future" - Wiley, New York, 1981

ACKOFF, R.L.: "A theory of Practice in the Social Systems sciences". Syst. Research, 5 (3) 1988

ACKOFF, Russell L.: "Redesigning the Future: Strategy" - Systems Practice, V.3, Nr.6, 1990

ACKOFF, Russell L.: "Ackoff's fables. Irreverent reflections on business and bureaucracy" - Wiley, New York, 1991

ACKOFF, Russell L.: "The Management of Change and the Changes it requires of Management" - Systems Practice, Vol.3, Nr.5, 1991

ACKOFF, R.L.: "Science in the Systems Age: Beyond IE, OR and MS", in Klir, G.(ed.): "Facets of Systems Science", Plenum Press, New York, 1991

ACKOFF, Russell L.: "The democratic organization"- Oxford University Press, New York, 1994

ACKOFF, R.L.: "Whole-ing" the parts and righting the wrongs". Syst. Research. 12 (1) 1995

ACKOFF, Russell L.: "On Pairs and Trios: The smallest Social Systems". Syst. Research 13 (4), 1996

ACKOFF, R.L. & GHARAJEDAGHI, J.: "Reflections on Systems and their Models", Syst. Research, 13 (1) 1996

ACKOFF, Russell L.: "Beyond total quality management (a lecture)"- University of Hull, sept.18, 1997

ACKOFF, Russell L.: "Exploring personality: an intellectual odyssey"- Inst. for Interactive Management, Philadelphia, PA, 1998

ACKOFF, Russell L.: "A systemic view of transformational leadership" - SPAR, 11 (1), 1998

ACKOFF, Russell L.: "Systems thinking inquiry across philosophy, science, arts and humanities"- Proc. 42th ISSS Meeting, Atlanta, 1998

ACKOFF, Russell L.: "Disciplines, the Two Cultures and the Scianities" - SRBVS, 16 (6), 1999

ACKOFF, Russell L.: "On passing through 80" - SRBVS, 12, (4), 1999

ACKOFF, Russell L.: "Fundamentalism and panaceas". SPAR, 14(1), 2001

ACKOFF, R. & POURDEHNAD, J.: "On misdirected systems" - SRBVS, 18(3), 2001

ACKOFF, R.L. & STRÜMPFER, J.P.: "Terrorism: a systemic view"- SRBVS, 20(3) 2003

ACKOFF, R.L. & ROVIN, S.: "Redesigning society"- Stanford Univ. Press, Stanford, CA., 2003

ACOSTA VERA, J.M.: "Time Management" in B. Banathy & R. Rodriguez Delgado(eds): "Intern. Syst. Science Handbook", Systems Publ., Madrid, 1993

ADAMKIEWICZ, Wiktor H.: "A multidisciplinary system approach to socio-econo-techno complexes as anticipatory systems"- CASYS J., 1, Univ. of Liège, Belgium, 1998

ADAMS, Richard: "Energy and structure", Univ. of Texas Press, Austin, 1975

ADAMS, Richard N.: "Energy and structure: a theory of social power"- University of Texas, Austin, 1975

ADAMS, Richard: "The eighth day: Social evolution as the self- organization of energy". Univ. of Texas Press, Austin, 1988

ADAMS, R. & WELSBY, J.: "Planning initiative: Researching decision making for children"- SPAR, 11(3) 1998

AGAPIE, Alexandru: "Genetic algorithms: theory and applications" - CASYS J., 7, Inst. Mathem., Univ. de Liège, 2000

AGAZZI, E. (ed.): "The problem of reductionism in science"- Kluwer Academic Press, Dordrecht, 1991

AHRNE, Göran: "Social organizations: interactions inside, outside and between organizations" - Sage, London, 1994

AIELLO, R. & SLOBODA, J.A.(eds.): "Musical perceptions"- Oxford Univ. Press, 1994

AIRAKSINEN, T. & GASPARSKI, W.(eds.): "Practical philosophy and action theory"- Transactions, Rutgers Univ., N.J., 1994

AIZAWA, V.: "Unbroken wholeness in nonlinear processes"- CASYS J., 2, Inst. de Mathem., Univ. de Liège, 1998

AKHMANOVA, O.S.: "On Psycholinguistics". SGSR Yearbook, 5, 1960

ALCOCK, John: "Animal behavior: an evolutionary approach"- Sinauer Assoc., Sunderland, MA., 1998

ALCOCK, John: "The triumph of sociobiology"- Oxford Univ. Press, 2001

ALEKSANDER, Igor: Opinion interview - N.Sc., Nr. 2252, August 19th, 2000

ALEXANDER, Christopher: "Notes on the synthesis of form". Harvard Univ. Press, Cambridge Mass., 1966

ALEXANDER, Christopher: "La estructura del Medio ambiente". Tusquets, Barcelona, 1971

ALEXANDER, Gary C.: "Interactive management: an emancipatory methodology"- SPAR, 15(2) 2002

ALEXANDER, J.C. et al.: "The micro-macro link". Univ. of California Press, Berkeley, CA, 1987

ALEXSONN, B. & EASTON, G.(eds.): "Industrial networks; a new view of reality"- Routledge, London, 1992

ALLEE, W.C. et al.: "Principles of animal ecology". Saunders, Philadelphia, 1938 (revised 1951)

ALLEN, Janet K.: "On evolution and engineering systems development"- Proc. 42nd ISSS Conference, Atlanta, 1998

ALLEN, Janet: "The development of a sustainable system under uncertainty" - Proc. 42nd ISSS Conf., Atlanta, 1998

ALLEN, P.M.: "New concepts in modelling human systems". Serv. Chimie-Physique II, Univ. Libre de Bruxelles, 1980

ALLEN, P.M.: "Self organization in the urban system", in Schieve, W. & Allen, P. (ed.): "Self organization and dissipative structures". Univ. of Texas Press, Austin, 1982

ALLEN, P.M. et al.: "New methods for policy exploration in complex systems". U.N. Conference, Montpellier, France, 1984

ALLEN, T.F.H. & STARR, T.B.: "Hierarchy: Perspectives for ecological complexity". Chicago Univ. Press, 1982

ALLEN, T.F.H.: "Hierarchical complexity in ecological systems". - 42nd Ann. Conf. ISSS, Atlanta, 1998

ALLEN, T.F.H., TAINTER, J. & HOEKSTRA, T.W.: "Supply-Side Sustainability" - SRBVS, 16, (5), 1999

ALLEN Janet & WILBY, Jennifer (eds): "Sustainable technology and complex ecological and social systems" - Proc. of the 42nd Annual Conference of the ISSS, Atlanta, 1998

ALLMAM, J. M.: "Evolving Brains." - Freeman, New York, 1998

- ALLWOOD, J. & GARDENFORS, P. (eds.): "Cognitive semantics: meaning and cognition" - J. Benjamins, Amsterdam, 1998
- ALQUIER, A.M. and PRINCE, V.: "The design of negotiative information systems". Proceedings ISSS, 35th Ann. Meet. vol.1, Ostersund, Sweden 1991
- ALRØ, Helle (red.): "Organisationsudvikling gennem dialog" - Universitetsforlag, Aalborg, 1996
- ALRØE, Hugo F.: "Science as systems learning; the cognitive and communicational aspects of science" - C&HK, 7(4) 2000
- ALVAREZ, R. & EMERY, M.: "From action research to systems in environments: a method" - SPAR, 13(5) 2000
- AMABILE, Carlos F. & al.: "Antibiotic Resistance Mechanisms". Amer. Scientist, V.83, July 1995
- AMABILE, Teresa: "The Social Psychology of Creativity" - Springer, New York, 1983
- AMABILE-CUEVAS, Carlos et al.: "Antibiotic Resistance" - American Scientist, Vol.83, Nr.1, July 1995
- AMIN, A. & HAUSNER, J. (eds.): "Beyond market and hierarchy" - Cheltenham, U.K., 1997
- AMIT, D.J.: "Modeling brain function. The world of attractor neural networks" - Cambridge University Press, Cambridge, 1989
- AMIT, D.J. et al.: "Correlations of hebbian cortical reverberations: Experiment vs. theory. J. of Neurosciences, 14, 1994
- ANANTHSWAMI, Amil: "Space babies" - N.Sc. nr. 2276, Febr.3, 2001
- ANANTHSWAMI, Amil: "A collective stomach drives wasp societies" - N.Sc., nov.2, 2002
- ANDERSEN, Gunnar: "Systems science as designing for continuity". Proc.14th Int. Congr. Cybernetics, Namur, 1995
- ANDERSEN, P.B.: "The semiotics of autopoiesis: a catastrophe-theoretic approach" - C&HK, 2(4), 1994
- ANDERSEN, P.B.: "WWW. As self-organizing system" - C&HK, 5(2) 1998
- ANDERSEN, Tom: "Reflekerende processer" - Dansk Psykologisk Forlag, Køttagmk "benhavn, 1994
- ANDERSON, Allan Ross (Ed): "Minds and machines". Prentice Hall, Englewood Cliffs, N.J., 1964
- ANDERSON, J.R. (ed.): "Cognitive skills and their acquisition" - Erlbaum, Hillsdale, N.J., 1981
- ANDERSON, J.R.: "The architecture of cognition" - Harvard Univ. Press, Cambridge, Mass., 1983
- ANDERSON, J.R.: "The adaptive character of thought" - Erlbaum, Hillsdale, N.J., 1990
- ANDERSON, J.R.: "Rules of the mind" - Erlbaum, Hillsdale, N.J., 1993
- ANDERSON, M. & MERRELL, F.(eds.): "On semiotic modelling" - Mouton, Berlin, New York, 1991
- ANDERSON, P.W.: "More is different: Broken Symmetry and the Nature of the Hierarchical Structure of Science" - Science, Vol 177, p. 393-6, 1972
- ANDLER, D. (ed.): "Introduction aux sciences cognitives" - Gallimard, Paris, 1992
- ANDREWSKY, Evelyne (Ed.): "Système et Cognition" - Dunod, Paris, 1991
- ANDREWSKY, Evelyne: "System Science, Psychology and Cognition", in B. Banathy & R. Rodriguez Delgado (eds.); Intern. Syst. Science Handbook", Systemic Publications, Madrid, 1993
- ANDREWSKY, Evelyne: "Some systemic approaches of cognition and language" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- ANDREW, Alex: "Self-organizing systems". Gordon & Breach, New York, 1989
- ANDREW, Alex: "What is there to know". Kybernetes, 23, (6-7), 1994
- ANGYAL, Andreas: "The structure of wholes". Philos. of Science, 6, 1939
- ANGYAL, A.: "A Logic of Systems", in Emery, F.E. (ed.): "Systems Thinking". Penguin, Harmondsworth, 1969
- ANSOFF, Igor & SLEVIN, Dennis P.: "An appreciation of industrial dynamics". Manag.Sci. 14 (7), 1968
- AOKI, M.: "Optimization of stochastic systems" - Academic Press, New York, 1967
- ***: "APPROCHES Cognitives de l'Organisation" - A Special issue of Rev. Intern. de Systématique (10, 1-2), 1996 with eight papers on this topic.
- ARACIL, Javier: "Introducción a la Dinámica de Sistemas". Alianza, Madrid, 1978
- ARACIL, Javier: "Bifurcations and structural stability in the dynamical systems modelling process". Syst. Research, 3 (4) 1986
- ARACIL, Javier: "Máquinas, Sistemas y Modelos: un ensayo sobre sistémica". Tecnos, Madrid, 1986
- ARBIB, Michael A.: "Brains, machines and mechanisms". Mc Graw Hill, New York, 1964
- ARBIB, Michael A.: "Theories of abstract automata". Prentice Hall, New York, 1968
- ARBIB, Michael: "The metaphorical brain". Wiley, New York, 1972
- ARBIB, M.A. & MANES, E.G.: "A category-theoretic approach to systems in a fuzzy world". Synthese 30 (3/4) 1975
- ARBIB, Michael: "Computers and the cybernetic society". Academic Press, 1977
- ARBIB, M.A. & HESSE, M.B.: "The construction of reality" - Cambridge Univ. Press, 1986
- ARBIB, Michael A.: "Brains, machines and mathematics". Springer, New York, 1987
- ARBIB, Michael A. (ed.): "The handbook of brain theory and neural networks" - MIT Press, Cambridge, MA., 1995
- ARECCHI, F.T. & FARINI, A.: "Lexicon of complexity" - Studio Editoriale Fiorentino, Florence, Italy, 1996
- ARECCHI, F. Tito: "Determinismo e complessità" - Armando Editore, Roma, 2000
- ARGYRIS, C.: "Reasoning, Learning and Action" - Jossey Bass, San Francisco, 1977
- ARGYRIS, Chris: "Understanding organizational change". SGSR Yearbook, 4, 1959
- ARGYRIS, C. & SCHÖN, D.A.: "Theory in practice: increasing professional effectiveness" - Jossey Bass, San Francisco, CA, 1974
- ARGYRIS, C. & SCHÖN, D.A.: "Organizational learning II: theory, method and practice" - Addison Wesley, Reading, MA, 1996
- ARIELY, Arie: "Some notes on Lilienfeld's Ideological Analysis". Cybern. Forum 9 (4) 1979
- ARIETI, Silvano: "Toward a Unified Theory of Cognition". SGSR Yearbook 10, 1965
- ARMELAGOS, George J.: "The Viral Superhighway" - The Sciences, V.38, nr. 1, Jan/Febr. 1998
- ARNAUD, P.: "Des moutons et des robots" - Presses Polytechniques et Universitaires Romandes, Neuchâtel, Switzerland, 2000
- ARNHEIM, Rudolf: "Visual thinking" - University of California Press, 1969
- ARNOLD, V.I.: "Catastrophe theory" Springer, New York, 1984
- ARNOTT, Richard & SMALL, Kenneth: "The economics of traffic congestion". Amer. Scientist, 82 (5) 1994
- ARROW, Kenneth: "Mathematical models in the social sciences". Gen. Syst. Yearbook, vol.1, 1956
- ARROW, Kenneth: "Social choice and individual values". Yale Univ. Press, 1963
- ARTHUR, Brian W.: "Increasing returns and path dependence in economy" - Univ. of Michigan Press, Ann Arbor, 1994
- ARTHUR, B.W., DURLAUF, S.N. & LANE, D.A. (Eds): "The Economy as an Evolving Complex System" - Addison Wesley, Reading, Ma, 1997
- ARTIGIANI, R.: "Revolution and evolution: applying Prigogine's dissipative structures model" - J.Soc. & Biol.Struct., 10(3)1987
- ARTIGIANI, Robert: "A model of societal self-organization", in George P. Scott (ed): "Time, rhythms and chaos". Iowa State Univ. Press, Ames, Iowa, 1991
- ARTIGIANI, R.: "Societal computation and the emergence of mind" - Evolution and Cognition, 2(1), 1996
- ARTIGIANI, R.: "Social information; the person is the message" - Biosystems, 46, 1998
- ARTS, W.(ed.): "Through a glass darkly: blurred images of cultural tradition and modernity over distance and time" - Brill, Leiden, 2000
- ASCHWANDEN, Christie: "Thread softly (about road effects zones)" - N.Sc., nr. 2226, febr.3, 2001
- ASHBY, Walter R.: "Statistical Machinery". Thales, nr.7 Paris, 1951
- ASHBY, Walter R.: "An Introduction to Cybernetics". Chapman & Hall, London, 1956
- ASHBY, Walter R.: "Requisite Variety and its implications for the control of Complex Systems". Cybernetica, 1 (2) 1958
- ASHBY, Walter R.: "Design for a Brain". 2nd. Ed., Chapman & Hall, London, 1960
- ASHBY, Walter R.: "Cybernetics Today". SGSR Yearbook, 8, 1963
- ASHBY, Walter R.: "The set theory of mechanisms and Homeostasis". SGSR Yearbook, 9, 1964
- ASHBY, Walter R.: "Principles of the self-organizing system", in W. Buckley (ed.): "Modern Systems Research for the Behavioral Scientist". Aldine, Chicago, 1968
- ASHBY, W.R. & MADDEN, R.: "The identification of many dimensional relations". Intern. J. of Syst. Science, V.3 (4), 1972
- ASHBY, Walter R.: "Introductory remarks", in M. Mesarovic (ed.): "Views on G.S. Theory". Krieger-Huntington, New York, 1974
- ASHBY, Walter R.: "Mechanisms of Intelligence" in "Ross Ashby's writings on Cybernetics". (ed. R. Conant). Intersystems Publ., Seaside, CA, 1981. (a quite complete source for Ashby's papers)
- ASPLUND, J.: "Det sociala livets elementära former" - Korpen. Göteborg, 1987
- ATIYAH, M.: "The geometry and physics of knots" - Cambridge Univ. Press, 1990

- ATLAN, Henri: "Du bruit comme principe d'auto-organisation". Communications n°18, Le Seuil, Paris, 1972
- ATLAN, Henri: "L'organisation biologique et la théorie de l'information". Hermann, Paris, 1972
- ATLAN, Henri: "Entre le cristal et la fumée". Le Seuil, Paris, 1979
- ATLAN, Henri: "Information theory and self-organization in ecosystems". Canad. Bul. of Fisheries, 1985
- ATLAN, Henri: "Natural complexity and self-creation of meaning". United Nations Univ., Tokyo, 1986
- ATLAN, Henri: "A tort ou à raison. Intercritique de la science et du mythe" - Le Seuil, Paris, 1986
- ATLAN, Henri: "Noise, complexity and meaning in cognitive systems". Rev. Intern. de Systémique, 3 (3) 1989
- ATLAN, Henri: "On a formal definition of organization". J. of Theor. Biology, 45, (p.295-304)
- ATMANSPACHER, H. & SCHEINGRABER, H. (eds.): "Information dynamics" - Plenum Press, New York, 1991
- ATMANSPACHER, H. & DALENOORT, G.J. (eds.): "Inside versus outside". Springer, Berlin, 1994
- ATMANSPACHER, Harald et al.: "Descartes revisited: the endo-exo-distinction and its relevance for the study of complex systems" - Complexity 1 (3), 1995
- ATMANSPACHER, Harald: "Cartesian cut, Heisenberg cut and the concept of complexity" - World Futures, 49, 1997
- ATMANSPACHER, Harald: "Exophysics, endophysics and beyond" - CASYS J. 2, Inst. Mathem., Univ. de Liège, 1998
- ATTINGER, E. (ed): "Global systems dynamics" S. Karger, Basel, 1971
- AUBIN, J.P.: "Viability theory". Birkhäuser, Berlin, 1991
- AUGER, Pierre: "Dynamics and thermodynamics in hierarchically organized systems". Syst. Research, 3 (1), 1986. (in French, "Dynamique et thermodynamique des systèmes composés de plusieurs niveaux d'organisation". Rev. Intern. de Systémique, 3 (2), 1989)
- AUGER, Pierre: "Hierarchically organized systems: biological systems". 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- AULIN, Arvid: "Methodological criticism". Syst. Research, 4 (2), 1987
- AULIN, Arvid: "Foundations of mathematical systems dynamics" Pergamon Press, Oxford, 1989
- AULIN-AHMAVAARA, A.: "The impossibility of genuine self-steering machines". Kybernetes 10 (2), 1981
- AUSTIN, J.J.: "How to do things with words" - Oxford Univ. Press, Oxford, 1962
- AVISON, D.E. & FITZGERALD, G.: "Information Systems Development: Methodologies, Techniques and Tools", 2nd Ed. - Maidenhead, Berkshire, 1995
- AXELROD, R & HAMILTON, W.D.: "The Evolution of Cooperation" - Science, Vol 211, p.1390-96, 1981.
- AXELROD, Robert: "The Evolution of Cooperation". Basic Books, New York, 1984
- AXELROD, Robert: "Advancing the Art of Simulation in the Social Sciences" - Complexity, Vol.3, Nr.2, 1997
- AXELROD, Robert: "The complexity of cooperation: agent-based models of competition and collaboration" - Princeton University Press, 1997
- AYER, A.J.: "Language, truth and logic". Dover, New York, 1952
- AYTON, Peter & ARKES, Hal: "Call it Quits" - N.Sc., Nr. 2135, May 23rd, 1998
- BABCOCK, L.M., et al.: "Some principles of pre-organization in self-organizing systems". Contract 1834 (21) Elect. Eng. Res. Lab., Univ. of Illinois, 1960
- BACHELARD, Gaston: "Le nouvel esprit scientifique". P.U.F., Paris, 1934
- BACHELARD, Gaston: "La formation de l'esprit scientifique". Vrin, Paris, 1947
- BACHELARD, Gaston: "La Philosophie du non". Presses Univ. de France, Paris, 1949
- BAECKER, Dirk(ed.) "Problems of form" - Stanford University Press, Stanford, 1999
- BAECKER, Dirk: "Niklas Luhmann sociological enlightenment" - C&HK, 6(3), 1999
- BAECKER, Dirk: "Why systems?" - Theory, Culture and Society, 16, 1999
- BAECKER, Dirk(ed.): "Kalkül der Form". Suhrkamp, Frankfurt a.M., 1993 a.
- BAECKER, Dirk(ed.): "Probleme der Form". Suhrkamp, Frankfurt a.M., 1993b.
- BAERT, Patrick (ed): "Time in contemporary intellectual thought" - North Holland/Elsevier, Amsterdam, 2000
- BAHG, Chang-Gen: "Major Systems Theories". Behav. Science, 35 (2) 1990
- BAHM, Archie: "The philosopher's world model". Greenwood Press, Westport, CT, 1979
- BAHM, Archie: "Five types of systems philosophy". Intern. J. of Gen. Systems, 6 (4), 1981
- BAHM, Archie: "Five systems concepts of society". Behav. Science, 28 (p.204-18), 1983
- BAHM, Archie: "Holons: three concepts" Syst. Research, 1 (2), 1984
- BAHM, Archie: "Wholes and parts of things". Contexts 2, (p.7-26), 1984
- BAHM, Archie: "The nature of existing systems". Syst. Research, 3 (3) 1986
- BAHM, Archie: "Why be moral?" World Books, Albuquerque, NM, 1992
- BAIER, Kurt & RESCHER, Nicholas(ed.): "Values and the Future" - Free Press, New York, 1969
- BAILEY, Kenneth D.: "Equilibrium entropy and homeostasis". Syst. Research 1 (1), 1984
- BAILEY, Kenneth D.: "Restoring order: relating entropy to energy and information". Syst. Research., 4 (2) 1987
- BAILEY, Kenneth: "Social entropy theory" - State Univ. of New York Press, Albany, 1990
- BAILEY, Kenneth: "Sociology and the New Systems Theory: toward a theoretical synthesis" - New York State Univ., New York, 1994
- BAILEY, Kenneth: "The autopoiesis of social systems: assessing Luhmann's theory of self-reference" - SRBVS, 14(2), 1997
- BAILEY, Kenneth: "Social ecology and living systems theory" - SRBVS, 15 (5), 1998
- BAILEY, Kenneth: "Sustainable technology and social entropy theory". 42nd. Ann.Conf. of the ISSS, Georgia Technology Institute., Atlanta, 1998
- BAILEY, Kenneth C.: "The emerging consensus in social systems theory" - Kluwer Acad.Press, New York, 2001
- BAILEY, Kenneth D.: "Towards unifying science: applying concepts across disciplinary boundaries" - SRBVS, 18(1), 2001
- BAILLY, F. et al.: "Fonctions biologiques, niveaux d'organisation et dimensions fractales". Rev. Intern. de Systémique, 2 (3) 1988
- BAILLY, F. et al.: "Hiérarchie de niveaux d'organisation biologique, processus de complexification et géométries fractales". Rev. Intern. de Systémique, 5 (1) 1991
- BAILLY, Francis: "Sur les concepts d'autonomie et d'hétéronomie". Rev. Internat. Systémique, 12(3) 1998
- BAIRD, John C.: "Linear man". Fields within fields, nr.12, 1974
- BAJURANEU, S.: "Determinism and information". Odobleja Newsletter, nr. 13-14, 1987
- BAK, Per, TANG, C. & WEISENFELD, K.: "Self-organized criticality" - Physical Review 38, 1988
- BAK, Per et al.: "Self-organized criticality in the Game of Life". Nature, 342, dec.14, 1989
- BAK, Per. & CHEN, Kan: "Self organized criticality". Sc.Amer., 264 (1) 1991
- BAK, P. & PACZUSKI, M.: "Why nature is complex" - Phys. World, Dec. 1993
- BAK, Per: "How Nature works: The Science of Self-organized Criticality" - Springer Verlag, New York, 1996
- BAK, Per: "It's all very simple, really" - N.Sc., Nr.2164, December 12th. 1998
- BAK, Per: "Think Life, Think Maths" - N.Sc., Nr.2155, October 10th, 1998
- BAKEHOUSE, George J.: "Information, its dimensions and quality" - 42nd. Ann. Conf. ISSS, Atlanta, 1998
- BAKER, G.L. & GOLLUB, J.P.: "Chaotic dynamics: an introduction". Cambridge University Press, New York, 1996
- BALACEANU, C. & NICOLAU, E.: "Les fondements cybernétiques de l'activité nerveuse". L'Expansion, Paris, 1971
- BALANDIN, R.K.: "Vladimir Vernadsky (Series: Outstanding Soviet Scientists)" MIR Publ., Moscow, 1982
- BALCH, T. & PARKER, L. (eds.): "Robot teams: from diversity to polymorphism" - A.K. Peters Ltd., 2002
- BALDWIN, J.M.: "A new factor in evolution" - The Amer. Natur., 30, 1896
- BALDWIN, J.M.: "Development and evolution" - Mac-Millan, New York, 1902
- BALE, L.: "Gregory Bateson, cybernetics, and the social behavioral sciences" - C&HK., 3 (1), 1995
- BALLONOFF, Paul A.: "Theory of rule-bound human systems" - C. & S., 25(6), 1994
- BALLONOFF, Paul A.: "More on the mathematics of rule-bound systems" - C. & S., 26 (4), 1995
- BALLONOFF, Paul: "Comparison of rule bound systems theory to traditional systems theory". Cyb. & Systems, 27 (4) 1996
- BALLONOFF, Paul A.: "On the evolution of self-awareness" - 15th Cybernetics & Systems Meet., Austrian Soc. for Cyb.Studies., Vienna, 2000
- BAMBERGER, J. & SCHÖN, D.: "Learning as reflective conversation with materials (in STEIFER, F. (ed.) "Research and reflectivity" - Sage, London, 1991
- BAMBERGER, Jeanne: "Unanswered questions (on D. SCHÖN's work)" - C&HK, 7(2-3) 2000

- BANATHY, Bela: "Developing a systems view of education". Intersystems Publ., Seaside, CA, 1973
- BANATHY, Bela: "The systems view of integrated development". The Alicante Conversation, I.S.I. V.1, San Francisco, 1985
- BANATHY, Bela: "The design of design inquiry". Intersystems, Seaside, CA, 1986
- BANATHY, Bela: "Choosing design systems". 31st. Conf. SGSR, Budapest, 1987
- BANATHY, Bela: "Matching design methods to systems type". Syst. Research, 5 (1) 1988
- BANATHY, Bela: "Systems design of education; a journey to create the future". Educational Technology Publications Inc., Englewood Cliffs, NJ, 1991
- BANATHY, Bela: "Designing social systems in a changing world". Cyb. & Systems Research 92, World Scientific, Singapore, 1992
- BANATHY, Bela & RODRIGUEZ DELGADO, Rafael (eds.): "International Systems Science Handbook", Systemic Publications, Madrid, 1993
- BANATHY, Bela: "Designing Social Systems: creating our future in a Changing World", in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Science Handbook", Systemic Public., Madrid, 1993
- BANATHY, Bela: "Systems Education: A General characterization", in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- BANATHY, Bela (ed): "Kenneth Boulding". Syst. Research, special issue, 12 (4), 1995
- BANATHY, Bela: "The 21st Century Janus: The three faces of Information". Syst. Research, 12 (4) 1995
- BANATHY, B.H.: "Designing social systems in a changing world" - Plenum Press, New York, 1996
- BANATHY, Bela A.: "Information-based Design of Social Systems". Behav. Science 41 (2), 1996
- BANATHY, B.H.: "The evolution of systems inquiry"- Systems, 2(1), Techn.Univ. Wroclaw, Poland, 1997
- BANATHY, Bela A.: "Information, Evolution and Change" - Syst. Practice 10 (1), 1997
- BANATHY, Bela H.: "Evolution guided by design: a systems perspective" - SRBVS, 15(3), 1998
- BANATHY, B. A.: "An Information Typology for the Understanding of Social Systems" - SRBVS, Vol.16, Nr.6, 1999
- BANATHY, Bela H.: "Systems Thinking in higher Education: Learning comes to Focus" - SRBVS, Vol.16, Nr.2, 1999
- BANATHY, Bela H.: "Self-guided/conscious evolution"- SRBVS, 20(4) 2003
- BANDURA, A.: "Self-efficacy mechanism in sociocognitive functioning" - Annual Meeting of the American Education Research Association, 1992
- BANGO, J. & KARACSONY, A.: "Luhmann's Funktions-systeme in der Diskussion"- Carl Auer Systeme Verlag, Heidelberg, 2001
- BANNISTER, D. (ed.): "Perspectives in personal construct theory". Academic Press, London, 1970
- BANVILLE, Claude et al.: "A stakeholder approach to multiple criteria decision aid" - SRBVS, 15(1), 1998
- BARABASI, Albert Laszlo: "Linked: the new science of networks"- Perseus, New York, 2002
- BARBIERI, Marcello: "The semantic theory of evolution"- Harwood Academic Publ., London, 1985
- BARBIERI, Marcello: "The organic codes: the birth of semantic biology"- Pequod, Ancona, 2001
- BARDMANN, Theodor M. (ed.): "Zirkuläre Positionen: Konstruktivism als praktische Theorie"- West-deutscher Verlag, Opladen, 1997
- BARDMANN, T. & LAMPRECHT, A.: "Systemtheorie Verstehen: eine multimediale Einführung" -West-deutscher Verlag, Wiesbaden, 1999
- BAREL, Yves: "Prospective et analyse de systèmes". Docum. Française, Paris, 1971
- BAREL, Yves: "La reproduction sociale: Invariance et changement". Anthropos, Paris, 1973
- BAREL, Yves: "Le paradoxe et le système. Essai sur le fantastique social" - Presses Univ. de Grenoble, 1979
- BAREL, Yves: "Système et paradoxe" (Une collection de textes) - Le Seuil, Paris, 1993
- BARENBLATT, G.I.: "Similarity, Self-similarity and intermediate asymptotes". Plenum Press, New York, 1979
- BARNARD, C.: "The functions of the executive"- Harvard Univ. Press, Cambridge, MA., 1938
- BARNELEY, M.: "Fractals everywhere".- Academic Press, Cambridge, 1993
- BARNET, Adrian: "Safety in numbers"- N.Sc., Nr.276, feb. 3, 2001 (about undercrowding)
- BARREDA DELGADO, Armando: "La historia como sistema adaptativo: cibernética e historia"- Universidad Inca Garcilaso de la Vega, Lima, Perú, 2002
- BARROW, John & TIPLER F.J.: "The anthropic cosmological principle". Oxford Univ. Press, 1986
- BARROW, John D.: "Platonic relationship in the Universe?". New Scientist, nr.1765, Apr.20, 1991
- BARROW, John: "Impossibility" - Oxford University Press, Oxford, 1998
- BARROW, John: "Is nothing sacred? " - N.Sc. Nr. 2196, July 24th. 1999
- BARROWS, H.S.: "The tutorial process"- South.Illin.Univ., Springfield, IL., 1988
- BARTHOLO, R.S. jr. "The scientific-technological dissolution of the meaning of life" in G.de Zeeuw (ed.) "Knowledge (dis) appearance." Systeem Groep Nederland, Delft Univ. Press, 1986
- BARTLETT, F. & JOHN, E.R.: "Equipotentiality quantified". Science, 181 (p.764-7)
- BARTO, Andrew G.: "Discrete and Continuous Models", Intern. J. Gen. Systems, 4 (3) 1978
- BARTUNEK, J.M. & MOCH, M.K.: 1st order, 2nd order and 3rd order change and organization development interventions: A cognitive approach" - Journal of Applied Behavioral Science, Vol.23, Nr.4, 1987 .
- BARY, H. A. de: "Die Erscheinung der Symbiose" - Trubner Verlag, Strassburg, 1879
- BASHIAS, N. & TAUSNER, M.: "Using distributed computing systems for systemic problem solving"- Proc. 42nd ISSS conference, Atlanta, 1998
- BATES, F. Eugene: "Self-organizing systems. The emergence of order" - Plenum Press, New York, 1987
- BATESON, G. & RUESCH, J.: "Communication: the social matrix of society". Norton, New York, 1951
- BATESON, Gregory: "Cybernetic explanation". The Amer. Behav. Sci., april 1967
- BATESON, Gregory: "Steps to an Ecology of Mind". Paladin, St.Albans (UK), 1973
- BATESON, Gregory: "Mind and nature: a necessary unity". Dutton, New York, 1979
- BATESON, G. & BATESON, M.: "Angels fear: towards an epistemology of the sacred" - Bantam Books, Toronto, 1988
- BATESON, Gregory: "Sacred unity: further steps to an ecology of mind"- Harper Collins, New York, 1991
- BATESON, P.: "The Active Role of Behavior in Evolution" - in HO, M.W. & FOX, S.W. (Eds): "Evolutionary Processes and Metaphors" - Wiley, New York, 1988
- BAUD, P. & NEIRYNCK, J.: "Première épître aux techniciens"- Presses Polytechniques et Universitaires Romandes, Lausanne, 1990
- BAUERSFELD, Heinrich: "Activity theory and radical constructivism"- C&HK, 1(2-3) 1992
- BAUMGARTNER, Tom et al.: "Open systems and multi-level processes: Implications for social research". Intern. J. Gen. Systems, 3 (1) 1976
- BAUSCH, Kenneth C.: "The HABERMAS-LUHMANN debate and subsequent Habermasian Perspectives on Systems Theory" - SRBVS, Vol.14, Nr. 5, 1997
- BAUSCH, Kenneth C.: "A confluence of paradigm and technology" - Proc. 42nd. ISSS Conf., Atlanta, 1998
- BAUSCH, Kenneth C.: "The practice and ethics of design"- SRBVS, 17(1), 2000
- BAUSCH, Kenneth C.: "Luhmann's ontology, ontogeny and epistemology" - SRBVS, 19(6), 2002
- BAWDEN, Richard: "I as in Academy: Learning to be systemic". Syst. Research. 12 (3) 1995
- BAWDEN, Richard: "Valuing the epistemic in the search for betterment: the nature and role of critical learning systems (CLS)"- C&HK, 7(4)2000
- BAYER, Hans Christian von : "In the beginning was the bit"- N.Sc., 2278, feb.17, 2001
- BAYER, Hans Christian von : "On close inspection" - The Sciences, 41(1), Jan.-Feb.2001
- BAYLISS, L.E.: "Mecanismos de Control de los Seres Vivientes" Oikos-Tau, Barcelona, 1968. (English original "Living control systems". English Univ. Press, London, and Freeman, San Francisco, 1966)
- BAZEMAN, Charles: "Shaping written knowledge" - Univ. of Wisconsin Press, Madison, Wis., 1989
- BAZEWICZ, Mieczyslaw: "Does there exist a systemic paradigm for future intellectual technologies"- Systems, Univ. Wroclaw, Poland, 1996
- BAZEWICZ, Mieczyslaw: "Socio-technological aspects of the information systems"- Polytechnical University Office, Wroclaw, Poland, 1996
- BAZEWICZ, Mieczyslaw (ed): "Informations Systems; Architecture and Technology" - Proc. 19th ISAT - Wroclaw Univ. of Technology, 1997
- BAZEWICZ, Mieczyslaw: "Development of information technology and globalization of systems sciences"- Systems, 2(2), Polytechnica Univ. of Wroclaw, Poland, 1997
- BAZEWICZ, Mieczyslaw: "On a systemic image of the nature of information" - Proc. 42nd ISSS Conf., Atlanta, 1998
- BAZEWICZ, Mieczyslaw: "Systems reasoning paradigm of the information image and nature"- Systems, 3(1) Polytechnic Univ. of Wroclaw, Poland, 1998
- BAZEWICZ, Mieczyslaw: "The axiological dimension of the nature of information in social communication systems"- Systems, 5(1/2), Polytechnical Univ. of Wroclaw, Poland, 2000
- BEALE, R. & JACKSON, T.: "Neural Computing: An Introduction" - Hilger, New York, 1991

- BEARD, C. & WILSON, J.P.: "The power of experimental learning"- Kogan Page, London, 2002
- BECHTEL, William & ABRAHAMSEN, Adele: "Connectionism and the Mind". Blackwell, Cambridge, Massachusetts, 1991
- BECK, Ulrich: "Was ist Globalisierung" - Suhrkamp, Frankfurt, 1998
- BECKER, A.L.: "Languaging across cultural boundaries"- Univ. of Michigan Press, Ann Arbor, MI, 1995
- BECKER, A. & NAIM, P.: "Les réseaux bayésiens"- Eyrolles, Paris, 1999
- BEDAU, Mark A.: "Philosophical aspects of artificial life" - Reed College, Portland, OR, 1996
- BEDNARZ, J.: "Autopoiesis: The organizational closure of social systems". Syst. Research, 5 (1), 1988
- BEDNARZ, J.: "System and Time in meaning constituting systems". Kybernetes, 19 (4) 1990
- BEER, R.D.: "Intelligence as adaptive behavior: an experiment in computational applications"- Academic Press, New York, 1990
- BEER, Randall et al.: "An artificial insect". Amer. Scientist, 79 (5) 1991
- BEER, Stafford: "The irrelevance of automation", Cybernetica, V.1 (4), 1958
- BEER, Stafford: "Below the twilight arch". ISGSR Yearbook, 5, 1960
- BEER, Stafford: "Decision and control". J.Wiley, New York, 1968
- BEER, Stafford: "Cybernetics and Management". English Univ. Press, London, 1971
- BEER, Stafford: "The brain of the Firm". Herder & Herder, New York, 1972
- BEER, Stafford: "The surrogate world we manage". Behav. Science, 18, 3, 1973
- BEER, Stafford: "Designing freedom". Wiley, London, 1974
- BEER, Stafford: "Platform for change". J. Wiley, New York, 1975
- BEER, Stafford: "The heart of the enterprise". Wiley, New York, 1979
- BEER, Stafford: "Death is equifinal". Behav. Science, 26 (3), 1981
- BEER, Stafford: "A reply to Ulrich's critique of pure cybernetic reason: the Chilean experience with cybernetics" J. Appl. Syst. Analysis, 10, 1983
- BEER, Stafford: "Diagnosing the systems for organizations" - Wiley, Chichester, 1985
- BEER, Stafford: "The surrogate world we manage: Fifteen years on". Opening plenary session of the World Future Conference, New York city, 1986
- BEER, Stafford: "Suicidal rabbits". Systems Practice: A special issue in honour of R.L. Ackoff, 1990
- BEER, Stafford: "About flat earths (Concordia University address on receiving his Honoris Causa Degree) C&HK, 1(1), 1992
- BEER, Stafford: "World in Torment". Kybernetes, 22, (6) 1993
- BEER, Stafford: "The Invention of Time Syntegrity". Wiley & Sons, Chichester, 1994
- BEER, Stafford: "Let us praise famous men- and women too: from Warren Mc Culloch to Candace Pert" - SPAR, 12(5) 1999
- BEESON, Ian: "Meaning: too much to specify" - In WILBY, J. & GREGORY, W. (eds.): Forum three: human consciousness and decision making. University of Hull, 1997
- BEESON, Ian: "Knowledge drains: automation and the loss of local expertise"- Proc. 42nd ISSS Conf., Atlanta, 1998
- BEHNKE, H., et al. (eds.): "Fundamentals of Mathematics", Vol.1 - M.I.T. Press, Cambridge, Mass., 1987
- BEISHON, John & PEETERS, Geoff (ed): "Systems behavior". Open Univ. Press, London, 1972
- BELBIN, R.M.: "Team roles at work" - Butterworth, London, 1993
- BELIS, Marianne: "Probabilité et Décision". Cybernetica, 30 (1) 1987
- BELL, Daniel: "The End of Ideology" - Free Press, Glencoe, 1960.
- BELL, Simon: "Self-reflection and vulnerability in action research"- SPAR, 11(2) 1998
- BELLMAN, Kirstie: "Developing a concept of self for constructed autonomous systems" - Proc. 13th Cyb. & Syst. Conference. Austrian Soc. for Cyb. Studies, Vienna, 2000
- BELOW, R.K. & MITCHELL, M. (eds.): "Adaptive individuals in evolving populations"- Addison Wesley, Reading, MA, 1996
- BENDALL, D.S.(ed.): "Evolution from Molecules to Men"- Cambridge Univ. Press, Cambridge, MA, 1983
- BENEDER, M. & CHROUST, G. (Eds): "Designing social systems in a changing world - the 9th Fuschl Conversation" - Austrian Society for Cybernetic Studies, Vienna, 1998
- BENEYTO, Rafael: "Status epistemológico de la Sistemica"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- BENI, G. & HACKWOOD, S.: "The maximum entropy principle and sensing in swarming intelligence". Proc. 1st Europ. Conf. on Artificial Life, Paris- MIT Press, Cambridge, 1992
- BENKING, H. & GROSSMANN, D.: "A conceptual superstructure of knowledge- Quality and content in organization, management and awareness"- CO-DATA Conf., Chambéry, France, 1994
- BENKING, Heiner: "Proposing a conceptual superstructure"- 20th International Congress of Surveyors, Melbourne, 1994
- BENKING, Heiner: "Maps, filters and brokers for higher-order knowledge-and-function-bases"- Research Institute for Applied Knowledge Processing (FAW), Univ. of Ulm, 1996
- BENKING, Heiner: "A metaparadigm or sharable framework (Cognitive Panorama)" - Council of Europe Conference, Prague Castle, 1996
- BENKING, Heiner: "Overview and orientation, or overclaims and oversimplifications"- Baden Baden Conference on Systems, 1997
- BENKING, H. & ROSE, J.: "A house of horizons and perspectives: a cognition deep openspace" - Proc. 42nd ISSS Conference, Atlanta, 1998
- BENNETT, J.W.: "The Ecological Transition: Cultural Anthropology and Human Adaptation" - Pergamon Press, New York, 1976
- BENNETT, R.J. & CHORLEY, R.J.: "Environmental systems: Philosophy, analysis and control" - Methuen, London, 1978
- BENSELER, F. & HEJL, P.: "Autopoiesis, communication and society".- Campus Verlag, New York, 1980
- BENYON, D.: "Information and data modelling"- 2 ed. Blackwell, Oxford, 1995
- BEREZIN, A. et al.: "Lifting the pernicious veil of secrecy". New Scient. 145, 1964, 1995
- BERG, L.S.: "Nomogenesis or evolution determined by law"- MIT Press, Cambridge, MA, 1969 (original in Russian published in 1922)
- BERGE, Claude: "Graphes et hypergraphes". Dunod, Paris, 1970
- BERGE, P., POMEAU, Y. & VIDAL, C.: "Order within Chaos"- Wiley, New York, 1984
- BERGER, Gaston: "Phénoménologie du temps et prospective". Presses Univ. de France, Paris, 1964
- BERGER Peter L. & LUCKMANN, Thomas: "The social construction of reality". Penguin Univ. Books, Harmondsworth, 1971
- BERGSON, Bryan: "The universal language" - Proc. 42nd ISSS Conference, Atlanta, 1998
- BERGVALL-KÄREBORN, B.: "Analysing the managerial concept of soft systems methodology and multimodal systems thinking"- Proc. 42nd ISSS Conference, Atlanta, 1998
- BERGVALL-KÄREBORN, Birgitta: "Enriching the model-building phase of soft systems methodology"- SRBVS, 18(1) 2001
- BERGVALL-KÄREBORN, Birgitta: "The role of the qualifying function concept in systems design"- SPAR, 14(1) 2001
- BERGVALL-KÄREBORN, Birgitta: "Qualifying function in SSM modelling: a case study"- SPAR, 15(4) 2002
- BERGÉ, P. et al.: "L'ordre dans le chaos". Hermann, Paris, 1984
- BERGÉ, P. et DUBOIS, M.: "Chaos déterministe expérimental et attracteurs étranges", in A. Dahan, Dalmedico et al.(eds.): "Chaos et déterminisme". Le Seuil, Paris, 1992
- BERK, Laura: "Why children talk to themselves". Sci. American 271 (5) 1994
- BERKOWITZ, A. et al.(eds.): "Understanding urban systems"- Springer Verlag, New York, 2001
- BERLINSKI, David: "Mathematical models of the world". Synthesis, V. 31, nr.2, 1975
- BERLINSKI, David: "On Systems Analysis". MIT Press, Cambridge, Mass., 1976
- BERNARD, Claude: "Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux". Bailière, Paris, 1878
- BERNARD, Claude: "Introduction à la Médecine Expérimentale" (original ed.1864). Flammarion, Paris, 1952
- BERNARD-WEIL, Elie: "L'arc et la corde". Maloine, Paris, 1975
- BERNARD-WEIL, Elie: "Précis de systématique ago-antagoniste". L'Interdisciplinaire, Lyon, 1988
- BERNARD-WEIL, Elie: "Systématique ago-antagoniste. Nouveaux développements"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- BERNARD-WEIL, Elie: "La théorie de l'autonomie peut-elle être autonome"- Rev. Internat. Systémique, 11(5) 1997
- BERRIDGE, M.: "The molecular basis of communication within the cells" - S. Amer., V.253, 1985
- BERRIEN, Kenneth F.: "General and social systems". Rutgers Univ. Press, New Brunswick, 1968
- BERTALANFFY, Karl Ludwig von: "Kritische Theorie der Formbildung"- Bornträger, Berlin, 1928

- BERTALANFFY, Karl Ludwig von: "Tatsachen und Theorien der Formbildung als Weg zum Lebensproblem"- Erkenntnis, 1(1930)
- BERTALANFFY, Ludwig von: "Untersuchungen über die Gesetzmäßigkeit des Wachstums". Roux Archive, V.131, 1934
- BERTALANFFY, Ludwig von: "Der Organismus als physikalisches System betrachtet". Die Naturwissenschaften, 28, 1940
- BERTALANFFY, Ludwig von: "Towards a physical theory of organic teleology". Human Biol., V. 23, Penguin, Harmondsworth, 1941
- BERTALANFFY, Ludwig von: "Zu einer allgemeinen Systemlehre". Blätter f. deutsche Philos., V.18, nr.3-4, 1945
- BERTALANFFY, Ludwig von: "Das Biologische Weltbild". Franke A.G. Verlag, Bern, 1949
- BERTALANFFY, Ludwig von: "Problems of organic growth". Nature, 156, 1949
- BERTALANFFY, Ludwig von: "An Outline of General Systems Theory". Brit. J. Phil.of Science, 1 (2) 1950
- BERTALANFFY, Karl Ludwig von: "The Theory of Open Systems in Physics and Biology" - Science, Vol 111, p. 23-29, 1950
- BERTALANFFY, Ludwig von: "Problems of Life". Watts & Co., London, 1952
- BERTALANFFY, Ludwig von: "Biologie des Fließgleichgewichts". Vieweg, Braunschweig, 1953
- BERTALANFFY, Ludwig von: "General Systems Theory". SGSR Yearbook, 1, 1956
- BERTALANFFY, Ludwig von: "An Essay on the Relativity of Categories". SGSR. Yearbook, 8, 1962
- BERTALANFFY, Ludwig von: "General systems theory: a critical review". SGSR Yearbook, 7, 1962
- BERTALANFFY, Ludwig von: "Modern theories of development". Harper Bros, New York, 1962
- BERTALANFFY, Ludwig von: "Robots, Men and Minds". Braziller, New York, 1967
- BERTALANFFY, Ludwig von: "General Systems Theory". Braziller, New York, 1968
- BERTALANFFY, Karl Ludwig von: "Organismic biology and systems theory" - Clark Univ. Press, Barre, Mass., 1968
- BERTALANFFY, Ludwig von: "The theory of open systems in physics and biology", in Emery, F.E. (ed): "Systems Thinking". Penguin, Harmondsworth, 1969
- BERTALANFFY, Karl Ludwig von: "The quest for systems philosophy" - Metaphilosophy, 3(2), 1972
- BERTALANFFY, Ludwig von: "Perspectives on General Systems Theory" (Ed.: E. Taschdjian). Braziller, New York, 1975
- BERTALANFFY, Ludwig von: "General systems theory: foundations, developments, applications". London, 1971
- BERTALANFFY, Ludwig von: "Systems view of man". (Ed. by Paul La Violette). Westview Press, Boulder, CO., 1980
- BERTELS, C.P. et al.: "Informatie: Een Interdisciplinaire Studie". AULA, Utrecht, 1968 (in Dutch)
- BERTHOZ, Alain: "Le sens du mouvement".- Odile Jacob, Paris, 1996
- BERTRAND, Yves et GUILLEMET, Patrick: "Les organisations. Une approche systémique" - Chotard, Paris, 1989
- BEUKEMA, Phillip L.: "System Level, value orientations: Nature and Reality". Intern. J. Gen. Systems, 1 (4) 1974
- BEURTON, P., FALK, R. & RHEINBERGER, H.J. (eds.): "The concept of the gene in development and evolution: historical and epistemological perspectives" - Cambridge, University Press, 2000
- BHARUCHA-REID, A.T.: "Elements of the theory of Markov Processes". Mc Graw Hill, New York, 1960
- BHASKAR, R.: "Scientific realism and human anticipation" - Verso, London, 1986
- BHASKAR, R.: "Reclaiming Reality"- Verso, London, 1989
- BIANCHI, G. et al.: "Long waves, depression and innovation". IASIA, Proc. Siena/Florence Meeting, 1983
- BICCHIERI, C. & DALLA CHIARA, C. (eds.): "Knowledge, belief and strategic interaction"- Cambridge Univ. Press, 1992
- BICKHARD, M.H. & TERVEEN, L.: "Foundational issues in artificial intelligence: impasse and solution"- North Holland, Amsterdam, 1996
- BICKHARD, Marik H.: "Function, anticipation, representation"- CASYS Conf. 2000, Proc. Univ. of Liège, 2001
- BIGGGIERO, Lucio: "Sources of complexity in human systems"- Proceed. 42nd ISSS Meet., Atlanta, 1998
- BINDE, Jérôme (ed.): "Quel avenir pour l'espèce humaine"- Seuil/UNESCO, Paris, 2000
- BINDRA, Dalbir & STEWART, Jane (Eds): "Motivation" - Penguin, Harmondsworth, Middlesex, UK, 1971 (A trove of essays by many outstanding psychologists representative of all important currents)
- BIRKHOFF, G.: "Lattice Theory". Amer. Math. Soc., Providence, 1961
- BISHOP, C.M.: "Neural networks for pattern recognition" - Clarendon Press, Oxford, 1995
- BJERKNES, G., EHN, P. & KYNG, M. (Eds.): "Computers and Democracy: The Scandinavian Challenge" - Avebury, Aldershot, 1987
- BLACKMORE, Susan: "The Meme Machine" - Oxford University Press, 1998
- BLACKMORE, Susan: "Meme, Myself, I" - N.Sc., Nr. 2177, March 13, 1999
- BLACKMORE, Susan: "The power of memes"- S. Amer., October 2000
- BLACKMORE, Susan: "The grand illusion: why consciousness only exists when you look for it" - N.Sc., nr.2348, Jun. 22, 2002
- BLANCO, Hilda: "The map of science collaboratory"- SRBVS, 19(5) 2002
- BLAUBERG, I.V., SADOVSKY, V.N., YUDIN, E.G.: "Systems theory: Philosophical and methodological problems". Progress Publishers, Moscow, 1977
- BLAYO, F. & VERLEYSEN, M.: "Les réseaux de neurones artificiels".- Que sais-je, nro. 3042, Pres.Univ.- France, Paris, 1996
- BLOCH, V. (ed.): "Cerveaux et machines".- Hermès, Paris, 1999
- BLUM, L. et al.: "Complexity and real computation"- Springer Verlag, New York, 1997
- BOCCARA, N.: "Les principes de la thermodynamique classique". P.U.F., Paris, 1968
- BOCHI, G. & CERUTI, M.: "La sfida della complessità". Feltrinelli, Milano, 1985
- BODE, H. et al.: "The education of a scientific Generalist". Science, 109, pp.553, 1949
- BODEN, Margaret: "Artificial intelligence and natural man". Basic Books, New York, 1977
- BODEN, Margaret: "Artificial intelligence and biological reductionism". in Mae-Wan Ho & Saunders, P.T.(eds.): Beyond Neo Darwinism. Academic Press, London, 1980
- BODEN, Margaret: "Minds and mechanisms: philosophical psychology and computational models". Cornell Univ. Press, Ithaca, New York, 1981
- BODEN, Margaret: "The social impact of thinking machines" Futures, febr. 1984
- BODEN, Margaret: "Computer models of mind: computational approaches in theoretical psychology". Cambridge Univ. Press, U.K., 1988
- BODEN, Margaret: "The creative mind: myths and mechanisms". Basic Books, New York, 1991
- BODEN, Margaret (Ed): "Dimensions of creativity". MIT Press, Cambridge, Mass., 1994
- BODEN, Margaret (Ed): "The Philosophy of artificial life". Oxford Univ. Press, New York, 1996
- BOGDANOV, A.A.: "Essays in Tektology". Intersystems, Seaside (CA), 1980. (Russian original 1921)
- BOGDANSKI, C.A.: "Programmation biotique et Triangle de Pascal". Rev. de Bio-mathématique, nr.15, Paris, 1966
- BOGDANSKI, C.A.: "L'apparition des phénomènes vitaux comme fonction du degré d'évolution des inégalités dans la distribution de la matière". Rev. Biomat. 8 (4) Paris, 1970
- BOGDANSKI, C.A.: "Introduction à la physico-cybernétique: traitement physique formel de l'ontogénèse des systèmes régulés". Odobleja Newsletter, nr.9, 1985
- BOGH ANDERSEN, P.: "www as self-organizing system".- C&HK., 4(2), 1998
- BOHM, David: "Wholeness and the Implicate Order". Routledge & Kegan Paul, London, 1980
- BOHM, David & PEAT, P. David: "Science, Order and Creativity". Bantam Books, New York, 1987
- BOHM, D. & HILEY, J.B.: "The undivided universe: an ontological interpretation of quantum theory".- Routledge, London, New York, 1993
- BOHM, David: "Thought as a system" - Routledge, London, 1994
- BOHM, David: "On dialogue"- Routledge, London, 1996
- BOK, J.: "Un modèle d'auto-organisation: Le principe de moindre difficulté". Colloque de Cérisy, Le Seuil, Paris, 1983
- BOK, S.T.: "Cybernetica" (in Dutch). Spektrum, Utrecht, 1970
- BOLAND, R.J. & HIRSCHHEIM, R.A. (Eds.): "Critical Issues in Information Systems Research" - Wiley, Chichester, 1987
- BONABEAU, Eric, et al.: "Swarm Intelligence: From Natural to Artificial Intelligence Systems" - Oxford Univ. Press, 1999
- BONABEAU, Eric & THERAULAZ, Guy: "Swarm Smarts" - S.Amer., March 2000
- BONITZER, Jacques: "Hasard et systèmes, quelques remarques". Rev. Intern. de Systémique, 2 (1) 1988
- BONNER, John T.: "Cells and societies". Princeton Univ. Press, New Jersey, 1955

- BONNER, John T.: "The evolution of development". Cambridge Univ. Press, 1958
- BONNER, J.T.: "Size and cycle: an essay on the structure of biology". Princeton Univ. Press, 1965
- BONNER, J.T.: "How behavior came to affect the evolution of body shape". *Scientia*, 118 (I-VIII), Milano, 1983
- BONNER, John T.: "The Evolution of Complexity". Princeton Univ. Press, New Jersey, 1988
- BONNER, John T.: "Life Cycles, Reflections of an Evolutionary Biologist" - Princeton Univ. Press, 1993 (In german: "Evolution und Entwicklung"- Vieweg, Braunschweig, 1995)
- BONNER, John T.: "First signals: the evolution of multi-cellular development" - Princeton Univ. Press, 2000
- BONSACK, François: "L'autonomie d'un système ouvert", in: "La systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, Bienne, Switzerland, 1990
- BONSACK, François: "Comment caractériser un système", in: "La systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, Bienne, 1990
- BONSACK, François: "Peut-on être à la fois cartésien et systémique", in "La Systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, Bienne, 1990
- BONSACK, François: "Réponse à M. Liu" in: "La systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, Bienne, 1990
- BONSACK, François: "A propos d'un réseau d'automates". Institut de la Méthode, Bienne, 1991
- BONSACK, François: "Le tout et ses parties: l'émergence de la finalité". Institut de la Méthode, Bienne, 1991
- BONSACK, François: "Une interprétation objectiviste de la théorie de l'information". Institut de la Méthode, Bienne, 1991
- BONSACK, François: "Nouvelles remarques sur l'émergence". Institut de la Méthode, Bienne, 1994
- BOOG, B. et al.: "Theory and practice of action research" - Tilbury Univ. Press, Tilbury (Netherlands) 1996
- BOOG, B.: "The complexity of relationships in action research" - Tilbury Univ. Press, Tilbury (Netherlands) 1998
- BOOKCHIN, Murray: "The ecology of freedom: emergence and dissolution of hierarchy" - Black Rose Books, New York, 1991
- BOOLE, George: "An Investigation of the Laws of Thought". Dover, New York, 1952. (Original edit. 1853)
- BOPRY, Jeanette: "Convergence toward enaction within educational technology" - C&HK, 8(4) 2001
- BORILLO, Mario: "Sciences Cognitives: une décentralisation réussie". La Recherche, n°258, 1993
- BOSCH, O.J. et al.: "Integrating science and management through collaborative learning" - SRBVS, 20(2) 2003
- BOTNARIUC, N.: "The Wholeness of Living Systems and some basic problems of Biology". SGSR Yearbook, 9, 1966
- BOUCHIKHI, Hamid: "Vers une approche constructiviste des structures organisationnelles". Rev. Intern. de Systémique, 4 (4), 1990
- BOUCHON, Bernadette (ed): "Entropies, Informations et Systémique". Analyse de Systèmes, XI (3), 1985
- BOUDON, Raymond: "Effets pervers et ordre social" - Presses Univ. de France, Paris, 1977
- BOULDING, Kenneth: "Implications for General Economics of more realistic theories of the Firm". Amer. Econ. Rev., 42 (2) 1952
- BOULDING, Kenneth: "G.S.T.; the Skeleton of Science". Manag. Sci., 2 (3) 1956, or SGSR Yearbook, 1, 1956
- BOULDING, Kenneth: "The Image". Univ. of Michigan Press, Ann Arbor, 1956
- BOULDING, Kenneth: "Towards a General Theory of Growth". SGSR Yearbook, 1, 1956
- BOULDING, Kenneth E.: "Economics and the behavioral sciences: a desert frontier" - Diogenes 15, 1956
- BOULDING, Kenneth: "General Systems as a Point of View", in M.D. Mesarovic (ed.): "Views on General Systems Theory". Wiley, New York, 1964
- BOULDING, Kenneth: "Business and Economic Systems", in Milsum, J. (ed): "Positive Feedback". Pergamon, New York, 1968
- BOULDING, Kenneth: "Economics as Science". McGraw Hill, New York, 1970
- BOULDING, Kenneth: "Economics and General Systems", in Laszlo, E (ed) "The relevance of G S T". Braziller, New York, 1972
- BOULDING, Kenneth: "The Shadow of the Stationary State". Daedalus, Fall 1973
- BOULDING, Kenneth: "The world as a total system". Sage, Beverly Hills, CA., 1974
- BOULDING, Kenneth: "The universe as a General System". Behav. Science, 22 (4), 1977
- BOULDING, Kenneth: "Ecodynamics: a new theory of societal evolution". Sage Publ., London, 1978
- BOULDING, Kenneth E.: "Evolutionary economics". - Beverly Hills, Sage Publ., 1981
- BOULDING, Kenneth: "Systems research and the hierarchy of world systems". Syst. Research, 2 (1), 1985
- BOULDING, Kenneth E.: "The world as a total system". - Sage Publ., Beverly Hills, CA., 1985
- BOULDING, Kenneth E.: "The human mind as a set of epistemological fields". Bull.Amer.Acad.Arts & Sci., 33(8) 1980, p. 14-30
- BOULDING, Kenneth E.: "Universal physiology" Behav.Sci., 25, 1980, p. 35-39
- BOULIGAND, Yves (Ed): "La Morphogénèse: de la biologie aux mathématiques". Maloine, Paris, 1980
- BOURDIEU, P. & PASSERON, J.C.: "La Reproduction: théorie du système d'enseignement" - Ed. De Minuit, Paris, 1970
- BOURDIEU, Pierre: "La distinction, critique sociale du jugement" - Ed. De Minuit, Paris, 1979
- BOURDIEU, Pierre: "La noblesse d'Etat: grandes écoles et esprit de corps" - Ed. De Minuit, Paris, 1989
- BOURDIEU, Pierre: "The logic of practice" - Polity Press, Cambridge, 1990
- BOURDIEU, Pierre: "Propos sur le champ politique" - Presses Univ. de Lyon, 2000
- BOURDIEU, Pierre: "Langage et pouvoir symbolique" - Le Seuil, Paris, 2001
- BOURGEOIS, Marcel: "La Systémique était un Humanisme" - Rev. Internat. de Syst., V.11, Nr.4, 1997
- BOUSSIAU, Paul (ed.): "Encyclopedia of Semiotics" - Oxford, Univ. Press, New York, 1998
- BOUTOT, Alain: "L'invention des formes: Chaos, catastrophes, fractals, structures dissipatives, attracteurs étranges" - O. Jacob, Paris, 1993
- BOWEN, Ken: "Some thoughts on multi methodology" - SPAR, 11(2), 1998
- BOWKER, G. et al.: "Social science, technical systems and cooperative work" - Erlbaum, Hillsdale, N.J., 1997
- BOWKER, G. & STAR, S.L.: "Sorting things out classification and its consequences" - MIT Press, Cambridge, MA, 1999
- BOWLER, Downing T.: "General Systems thinking: its scope and applicability". North Holland, New York, 1981
- BOYD, R & RICHESON, P.J.: "Culture and the Evolutionary Process" - Univ. Of Chicago Press, 1985
- BOYDEN, S.: "Hong Kong: a case study of a city and its inhabitants". Unesco, Paris, 1978
- BRAHMS, Sabre: "Experimenting with the dynamic usage of models" - Proc. 45th ISSS Conf., Asilomar, CA, 2001
- BRAHMS, Sabre: "The dynamic usage of models (DYSAM)" - Proc. 2nd Italian Systems Conference. Kluwer, Dordrecht, 2002
- BRAICHET, A.: "Sur la diversité et la structure du temps". Institut de la Méthode, Bienne, 1992
- BRAND, Gerd: "Welt, Ich und Sein: Nach unveröffentlichten Manuskripten Edmund Husserl's" - M. Nijhoff, Den Haag, 1955
- BRANDON, R.N.: "Concepts and methods in evolutionary biology" - Cambridge Univ. press, Cambridge, MA, 1996
- BRATEN, Stein: "Dialogic mind: the infant and the adult in protoconversation", in M.E. Carvallo (ed.): "Nature, cognition and system". Kluwer, Amsterdam, 1988
- BRAUDEL, Fernand: "On history" (Trans. Sarah Matthews) - Univ. of Chicago Press, 1980
- BRAUDEL, Fernand: "Civilization and capitalism" 3 vol. Fontana Press, London, 1982 (Original in French)
- BRAVOS, A.G. & Greene, P.G.: "Body-based Learning using Percept Agents". Cybernetics and Systems Research 92, World Scientific, Singapore, 1992
- BRAYBROOKE, D. & LINDBLOM, C.E.: "Strategy of decision". Free Press, Glencoe, New York, 1963
- BREEMERSCH J.P. & EHRESMANN, A.C.: "A learning model for complex systems based on Category theory", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada
- BREIDBACH, O., RUSCH, G. & SCHMIDT, S.: "Interne Repräsentationen" - Suhrkamp, Frankfurt/M., 1996
- BREITENBERG, V.: "Experiments in synthetic psychology" - MIT Press, 1984
- BREMERMAN, H.: "Optimization through evolution and re-combination" - in Yovits, M. et al.: Self-organizing systems, Spartan Books, Washington d.C., 1962
- BRENTANO, F.: "Psychologie du point de vue empirique" - Aubier, Paris, 1944
- BRENTANO, Franz: "Psychologie vom empirischen Standpunkt" (1874) - Edited and republished by O. Krauss- Felix Meiner, Hamburg, 1955

- BRESCH, Carsten: "Zwischenstufe Leben: Evolution ohne Ziel?" R. Piper & Co. Verlag, München, 1977. In Spanish: "La vida, un estado intermedio". Salvat, Barcelona, 1987 (This translation used)
- BRIEFS, U., CIBORRA, C. & SCHNEIDER, L. (Eds.): "Systems design for, with and by the users" - North Holland, Amsterdam, 1983
- BRIER, Sören: "Information and consciousness: a critique of the mechanistic foundation of the concept of information" - C&HK, 1(2/3), 1992
- BRIER, Sören: "A cybernetic and semiotic view on a Galilean theory of psychology" C&HK, 2 (2), 1993
- BRIER, Sören: "Conversational ethics and the global environment" - C&HK, 1(4) 1993
- BRIER, Sören: "Cyber-semiotics: on autopoiesis, code-duality and sign games in bio-semiotics" - C&HK, 3 (1) 1995
- BRIER, Sören: "From 2nd order cybernetics to cyber-semiotics: a semiotic re-entry into the 2nd order cybernetics of Heinz von Foerster" - SRBVS, 13(3) 1996
- BRIER, Sören: "Do infons have organizing power and emergence as meaning?" - C&HK, 5(4) 1998
- BRIER, Sören: "The cybersemiotic explanation on the emergence of cognition" - Evolut. & Cognit. 4 (1), 1998
- BRIER, Sören: "Biosemiotics and the foundation of cybersemiotics" - Semiotica, 127 (1/4), 1999
- BRIER, Sören: "Biosemiotics as a possible bridge between embodiment in cognitive semantics and the motivation concept of animal cognition in ethology" - C&HK, 7(1) 2000
- BRIER, Sören: "Trans-scientific frameworks of knowing: complementary views of the different types of human knowledge" - SRBVS, 17(5), 2000
- BRIER, Sören: "Cybersemiotics and Umweltlehre" - Semiotica, 134 (1/4) 2001
- BRIER, Sören: "Cybersemiotics: a reconceptualization of the foundations for information science" - SRBVS, 18(5), 2001
- BRIER, S. & BOPRY, J.: "Hermeneutic Cybernetics" - C&HK, 9(3/4) 2002
- BRIER, Sören: "Semiotic machines-cybernetic minds" - C&HK, 9(1) 2002
- BRIER, Sören: "The five-levelled cybersemiotic model of FIS" - Proceed. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- BRIER, Sören: "Varela's contribution to the creation of cybersemiotics: the calculus of self-reference" - C&HK, 9(2) 2002
- BRIER, Sören: "Cybersemiotics: for a transdisciplinary framework for description of observing anticipatory and meaning production systems" - CASYS J., Liège, 1997
- BRIGGS, J. & PEAT, F.D.: "Turbulent mirror". Harper & Row, New York, 1989 (In French: "Un miroir turbulent". Interéditions, Paris, 1991)
- BRIGHT, Chris: "Life out of bounds" - W.W.Norton, New York, 1998
- BRILLOUIN, Léon: "Mathematics, physics and information". Information & Control, V.1, 1957
- BRILLOUIN, Léon: "Vie, matière et information". Albin Michel, Paris, 1959
- BRILLOUIN, Léon: "Science and Information Theory". Academic Press, New York, 1962
- BRILLOUIN, Léon: "Scientific uncertainty and information" Academic Press, New York, 1964
- BRILLOUIN, Léon: "Thermodynamics and Information Theory", in Buckley, W.(ed) "Modern Systems Research for the Behavioral Scientist". Aldine, Chicago, 1968
- BRIM, Lubos: "Analysing time aspects of dynamic systems". Cybernetics and Systems Research 92, World Scientific, Singapore, 1992
- BRITTON, G.A.: "A methodology for using Beer's Viable System Model". Cyb. & Systems, 20 (4) 1988
- BRITTON, G.A. & McCALLION, H.: "An overview of the Singer, Churchman, Ackoff school of thought". Syst. Pract.7(5) 1994
- BRIX, V.H.: "Cybernetics in Management". Odobleja Newsletter, nr. 5, 6 & 7, 1984
- BRIX, V.H.: "Social Cybernetics: A Psychology of Industry and Politics". Odobleja Newsletter, nr. 16-17, 1988
- BRIX, V.H. (ed): "Autonomie et interdépendance". Analyse de Systèmes XV (1) 1989
- BROAD, C.D.: "Perception, physics and reality" - Cambridge University Press, London, 1914
- BROADBENT, D.E.: "Perception and communication". Pergamon, New York, 1958
- BROCKLESBY, J. & CUMMINGS, S.: Combining hard, soft and critical methodologies of systems research: The cultural constraints" - Systems Research, Vol. 12, Nr.3, 1995
- BROCKLESBY, J.: "Intervening in the cultural constitution of systems - methodological complementarity and other visions for systems research" - Journal of the Operational Research Society, Nr. 46, 1995
- BROCKMAN, John: "The third culture: beyond the scientific revolution" - Simon & Schuster, New York, 1995
- BRODLEY, Carla, LANE, Terran & STOUGH, Thimoty: "Knowledge Discovery and Data Mining" - Amer. Scientist, V.87, Nr.1, 1999
- BROEKSTRA, Gerrit: "On the representation and identification of structure systems". Intern. J. of Syst. Science, 9 (11) 1978
- BROEKSTRA, Gerrit: "Toward a theory of organizational Change". Cybernetics & Systems Research 92. World Scientific, Singapore, 1992
- BROEKSTRA, Gerrit: "The Systems Paradigm in Organization and Management: from open systems to the Chaos Hypothesis", in B.Banathy & R.Rodriguez Delgado (eds.): "Int. Syst. Science Handbook". Systemic Publications, Madrid, 1993
- BROEKSTRA, Gerrit: "Problems of chaotic Simplicity: Weaver revisited". in R. Trappl(ed.): "Cybernetics and Systems'94". World Scientific, Singapore, 1994
- BROEKSTRA, Gerrit: "Unmanagement: do the emperors still have clothes?" - Proceed. 14th Meet. on Cybernetics and Systems, Vienna, 1998
- BROEKSTRA, Gerrit: "Constraint analysis of discrete multivariate system" - Proc.26th Ann.Meet.SGSR, 1982, p. 259-265
- BROGLIE, Louis de: "Sens philosophique et portée pratique de la cybernétique" (1953). Reprint in Rev. Intern. de Systémique, 3 (2), 1989
- BRONOWSKI, J.: "New concepts in the evolution of complexity". Zygon, 5 (1), 1970
- BROOKES, Martin: "Hard Cell, Soft Cell" - N.Sc.nr. 2206, October 2nd, 1999
- BROOKS, R.D. & WILEY, E.O.: "Evolution as entropy: toward a unified theory of biology" - Univ. of Chicago Press, Chicago, 1986
- BROOKS, Robert (ed): "Neural Computation". MIT Press, 1989
- BROOKS, Robert: "Intelligence without Reason". in 12th Internat. Joint Confer. on Artif. Intell. Proceedings, Morgan Kaufmann, 1991
- BROOMHEAD, Dave: "Keeping a close Check on Chaos". Physics World, July 1990
- BROOMHEAD, Dave: "Guidance on the Control of Chaos". Physics World, Aug. 1992
- BROWN, J.S. & DUGUID, P.: "The social life of information" - Harvard Business School Press, Boston, MA, 2000
- BROWN, Kathryn: "Life on the edge" - N.Sc., Nr. 2213, November 20, 1999)
- BROWN, Lester R. et al.: "State of the world" - Annual publication. Norton, New York, 1984 on
- BROWN, M.T. & ULGIATI, S.: "Emergy basis for ecosystem management: valuing the work of nature and humanity" - Proceed. 42nd ISSS Meet. Atlanta, 1998
- BROWN, Mandy & PACKHAM, Roger: "Organisational Learning, Critical Systems Thinking and Systemic Learning" - Research Memorandum, Nr. 20, Univ of Hull, 1999
- BROWN, Sylvia M.: "A Systemic Perspective on Higher Education in the United Kingdom" - SRBVS, Vol.16, Nr.2, 1999
- BROWN, Steven R.: "Peirce, Searle and the chinese room argument" - C&HK, 9(1) 2002
- BRUCE, V. & GREEN, P.: "Visual perception: physiology, psychology and ecology" - 2ed. L. Erlbaum, N.J., 1990
- BRUER, J.T.: "The myth of the three first years: early brain development and lifelong learning" - Simon & Schuster, Riverside, NJ., 1999
- BRUGHA, Cathal M.: "Systems thinking in China: a meta decision making bridge to western concepts" - SPAR, 14(3) 2001
- BRUIN, N.B.M.: "Durkheim en de toepassing van de systematische methode op sociale verschijnselen" (in Dutch) (Durkheim and the applications of the systematic (or systemic) methodology to social phenomena) - Systemica, 5(1), Utrecht, 1985
- BRUN, Herbert: "Technology and the Composer". in H.von Foerster (ed): "Interpersonal Relational Networks". Centro Intercultural de Documentación, Cuernavaca, MEXICO, 1971
- BRUNEL, N.: "Hebbian learning of context in recurrent neural networks" - Neural Computation, 8, 1996
- BRUNER, J.: "Acts of Meaning" - Harvard Univ. Press, Cambridge, Mass, 1990
- BRUNET, Jean: "Apologie et critique du Principe Cosmo-physique chez Edgar Morin". Cybernetica, 30 (1) 1987
- BRUNO, David & LAURIN, Bernard: "Quantifier les ressemblances entre espèces" - La Recherche, nr. 296, mars, 1997
- BRUNTLAND Gro Harlem: "Our common future (World Commission on Environment and Development)" - Oxford University Press, New York, 1987
- BRUTER, Claude P.: "Sur la nature des mathématiques". Gauthier Villars, Paris, 1973
- BRUTER, Claude P.: "Topologie et perception". V. 1, Maloine-Doin, Paris, 1974
- BRUTER, C.P.: "Introduction à la théorie des ensembles flous" (a review). Intern. J. Gen. Syst., 2 (2) 1975

- BRUTER, Claude P.: "La Notion de Singularité et ses applications". *Rev. Intern. de Systémique*, 3 (4) 1989
- BRYANT, John: "Systems Theory and Scientific Philosophy". University Press of America, Lanham, Maryland, 1991
- BUCHANAN, Mark: "Fascinating rhythm" - *N.Sc.*, January 3rd, 1998
- BUCHANAN, Mark: "World of Patterns" - *N.Sc.*, Inside Science Nr. 121, June 19th, 1999.
- BUCHANAN, Mark: "It's flaming freezing" - *N.Sc.*, July 15th, 2000
- BUCHANAN, Mark: "Ubiquity" - Weidenfeld and Nicholson, London, 2000
- BUCHANAN, Mark: "Nexus" (in Britain: "Small worlds" - Weidenfeld and Nicholson, London, 2002
- BUCHANAN, Mark: "Small world" - Weidenfeld & Nicholson, London, 2003
- BUCHBERGER, Ernst (comp.): "A.I. Dictionary". Österreichische Gesellschaft für Artificial Intelligence, Wien, 1987
- BUCK, R.C.: "On the logic of general behavior systems theory". in H. Feigl & M. Scriven (eds.): *Minnesota Studies in the Philosophy of Sciences*, V.1. Univ. of Minnesota Press, Minneapolis, 1956
- BUCKLEY, Walter: "Sociology and modern systems theory" Prentice Hall, Englewood Cliffs, New Jersey, 1967
- BUCKLEY, Walter(ed): "Modern systems research for the behavioral scientist". Aldine Publ.Co., Chicago, 1968
- BUFFON (Georges-Louis Leclerc, Comte de): "Premier discours de la manière d'étudier et de traiter l'histoire naturelle" (1749) - in *La Recherche*, Nr.326, Décembre 1999
- BUGIARELLO, George: "Biology, society and machines" - *Amer. Scientist*, V.86, Nr.2, 1998
- BUHL, Walter L.: "Sozialer Wandel in Ungleichgewicht: Zyklen, Fluktuationen, Katastrophen" - Enke, Stuttgart, 1990
- BUNDLE, A. & HAVLIN, S. (eds.): "Fractals and disordered systems" - Springer, Berlin, 1993
- BUNGE, Mario: "Qué es y para qué sirve la epistemología?" *Rev. Univ. de México*, 31 (2), 1976, p. 1-7
- BUNGE, Mario: "Scientific research: I. The search for System". Springer, New York, 1967
- BUNGE, Mario: "Théorie de la causalité" - P.U.F., Paris, 1971
- BUNGE, Mario: "Teoría y realidad". Ariel, Barcelona, 1972
- BUNGE, Mario: "Method, model and matter". Reidel, Boston, 1974
- BUNGE, Mario: "Things". *Intern. J. Gen. Systems*, 1 (4) 1974
- BUNGE, Mario: "The G.S.T. Challenge to the Classical Philosophies of Science" *Intern. J. Gen. Systems*, 4 (1) 1977
- BUNGE, Mario: "A Systems concept of society: Beyond individualism and holism". *Theory & Decision*, 10, 1979
- BUNGE, Mario: "Causality and modern science". Dover, New York, 1979
- BUNGE, Mario: "Treatise on Basic Philosophy - Vol.4 (II): Ontology II: A World of Systems". Reidel, Dordrecht, 1979
- BUNGE, Mario: "Epistémologie". Maloine, Paris, 1983
- BUNGE, Mario: "Analytic Philosophy of Society and Social science: the systemic approach as an alternative to holism and individualism". *Rev. Intern. de Systémique*, 2 (1) 1988
- BUNGE, Mario: "Game theory is not a useful tool for the political scientist" - *Epistemologia* 12, 1989
- BUNGE, Mario: "Social Systems" in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Science Handbook". Systemic Publications, Madrid, 1993
- BUNGE, Mario: "Sistemas sociales y filosofía". Sudamericana, Buenos Aires, 1995
- BUNGE, Mario: "Ciencia, técnica y desarrollo" - Ed. Sudamericana, Buenos Aires, 1997
- BUNNEL, Pille: "Attributing nature with justifications" - *SRBVS*, 17(5), 2000
- BURGER, Henry G.: "Agonometry: Adaptability through Rivalry". *SGSR Yearbook*, 12, 1967
- BURKS, A.W. (ed): "The theory of self-reproducing automata". Univ. of Illinois Press, Urbana, 1966
- BURKS, A.W.: "Essays on cellular automata". Univ. of Illinois, Urbana, 1968
- BURNOD, Yves: "An adaptive neural network: the cerebral cortex" - Academic Press, Masson, Paris, 1987
- BURNS, T.R. & MEEKER, D.: "A Systems Theory of Multi-level, Multiple Objective Evaluation and Decision Making". *Intern. J. Gen. Systems*, 3 (2) 1976
- BURNS, Tom & FLAM, Helen: "The shaping of social organization: Social rule system theory" - Sage, Beverly Hills, 1987
- BUSHEV, M.: "Synergetics, Chaos, Order, Self-Organization" - World Scientific, Singapore, 1994
- BUSS, Leo: "The Evolution of Individuality" - Princeton Univ. Press, 1987
- BUTTS, R. & BROWN, J. (eds.): "Constructivism and science" - Kluwer, Dordrecht, 1989
- BYRNE, D.: "Complexity theory and the social sciences" - Routledge, London, 1998
- CAIANIELLO, E.R.: "A thermodynamical approach to hierarchical self-organizing systems". IASA Seminar, Laxenburg, Austria, July 1979
- CAILLIAU, Robert: "How the Web was born" - Oxford Univ. Press, 2000
- CAINE, Renate N. & Geoffrey: "Making Connections: Teaching and the Human Brain". Addison Wesley, Reading, Massachusetts, 1994
- CAIRNS-SMITH, A.G.: "Genetic take-over and the mineral origins of life" - Cambridge, Univ. Press, New York, 1982
- CALDIROLO, Piero: "Ruolo de la complessità nella descrizione fisica dei sistemi biologici". *Scientia*, 75 (5-8) 1975 (English translation in the same issue)
- CALHOUN, John B.: "Population Density and Social Pathology". *Sc.American*, 206 (2) 1962
- CALHOUN, John B.: "An evolutionary perspective on the environmental crisis". *Fields within Fields*, nr.13, 1974
- CALLENBACH, E., CAPRA, F. et al.: "Eco Management" - Berrett, Koehler, San Francisco, 1993
- CALLO, V.N. & PACKHAM, R.G.: "The Use of Soft System Methodology in Emancipatory Development" - *SRBVS*, Vol.16, Nr.4, 1999
- CAMAZINE, S. et al.: "Self-organization in biological systems". - Princeton Univ. Press, 2001
- CAMBELL, A.B.: "The Social Aspects of Population Dynamics". in R.M. Chute(ed.): "Environment Insight". Harper & Row, New York, 1971
- CAMBELL, A.B.: "Applied chaos theory. A paradigm for complexity". Academic Press, New York, 1993
- CAMBOUROPOULOS, E.: "Towards a general theory of musical structures" - Faculty of Music, Univ. of Edinburgh, 1998
- CAMERON, W.: "Autopoiesis and accident: criteria for the attribution of life" - *SRBVS*, 18(6) 2001
- CAMPBELL, D.T.: "Adaptive behavior from random response" - *Behav. Science*, 1, 1956
- CAMPBELL, Donald T.: "Blind Variation and Selective Retention". *Psychological Review*, V. 67, 1960
- CAMPBELL, Donald T.: "Comparative Psychology of knowledge Processes". *SGSR Yearbook*, 6, 1961
- CAMPBELL, D.T.: "Evolutionary epistemology" (in Schilpp, P.A.(ed.): *The philosophy of Karl Popper* - Open court Publ., 1974
- CAMPBELL, Donald T.: "On the conflicts between biological and social evolution and between psychology and moral tradition". *Amer. Psychologist*, 30, 1975
- CAMPBELL, Donald T.: "Downward Causation in hierarchical selective retention and/or feedback Systems". *ASC., Cybern. Forum*, 8 (3/4) 1976
- CAMPBELL, Jeremy: "Grammatical man: information, entropy, language and life" - Simon & Schuster, New York, 1982
- CAMPBELL, N.R.: "Foundations of science: the philosophy of theory and experiment". Dover, New York, 1957
- CAMPBELL WILLIAMS, Mark: "Rich pictures on the path towards systemic being" - *SRBVS*, 16(4), 1999
- CANNON, Walter: "The Wisdom of the Body". Norton, New York, 1967
- CAO, Guanming et al.: "Diversity management in organizational change: toward a systemic framework" - *SRBVS*, 20(3) 2003
- CAO, Y.U., FUKUNAGA, A.S. & KAHNG, A.B.: "Cooperative mobile robotics: Antecedents and directions" - *Autonomous Robots*, 4, 1997
- CAPRA, Fritjof: "The turning point" - Simon & Schuster, New York, 1982
- CAPRA, Fritjof: "Uncommon wisdom" - Simon & Schuster, New York, 1988
- CAPRA, Fritjof: "The Tao of Physics". (3 ed. Updated). - Shambala, Boston, 1991
- CAPRA, Fritjof: "The web of life" - Anchor Books, New York, 1997
- CARIANI, Peter: "Adaptability and emergence in organisms and devices" - *World Futures*, 32, 1991
- CARMICHAEL, Robert D.: "Groups of Finite Order". Dover, New York, 1956
- CARNEIRO, R.L.: "A Theory of the Origin of State" - *Science*, 169, p.733-8, 1970
- CARROLL, J.M.: "Scenario based design: envisioning work and technology in system development" - Wiley, 1995
- CARRUTHERS, Martyn: "Human consciousness and decision-making." - in Wilby, J. & Gregory, W.(eds.): *Forum three*. University of Hull, 1997
- CARTER, Rita: "Brain and the nervous system" - Society of Neuroscience, Hancock, MD, 1998
- CARTER, Rita: "Mapping the Mind" - Univ. of California Press, Los Angeles, CA, 1998

- CARTERTE, E.C. & FRIEDMAN, M.P. (ed.): "Handbook of perception: historical and philosophical roots"- Academic Press, New York, 1974
- CARVALLO, M.E. (ed): Nature, cognition and systems". Reidel, Dordrecht, 1987
- CASELLES, Antonio: "Technology assessment from General Systems Theory". Proc. 2nd Eur. Congr. Syst. Science, Praha, 1993
- CASELLES MONCHO, A. & USO DOMENECH, J.L.: "Modelling Ecosystems", in B. Banathy & R. Rodriguez Delgado (eds.): Intern. Syst. Sc. Handbook. Systemic Publications, Madrid, 1993
- CASELLES MONCHO, A., Antonio: "An application of systems based technology assessment to choose among several urban projects"- Rev. Internat. systématique, 6(1-2) 1994
- CASELLES MONCHO, A., Antonio: "Modelización de ecosistemas"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- CASTAGLI, & EUBANK, S. (eds.): "Nonlinear modelling and forecasting" - Santa Fe Inst. Stud. Sc. of Complexity, Vol. XII., Addison Wesley, Reading, MA, 1992
- CASTELL, A. et al.(eds.): "Synergy matters: working with systems in the 21st Century"- Kluwer, New York, 1999
- CASTELLS, Manuel : "The information age" - Cambridge, University Press, Cambridge, MA, 1996
- CASTELLS, Manuel: "La société en réseaux; l'ère de l'information"- Fayard, Paris, 1998 (Original in Spanish, Alianza, Madrid, 1996)
- CASTELLS, Manuel: "The rise of the network society"- Blackwell, Oxford, 1996
- CASTI, John: "Connectivity, complexity and catastrophe in large scale systems". Wiley, New York, 1979
- CASTI, J. & KARLQVIST, A.(eds.): "Real brains, artificial minds"- North Holland, New York, 1987
- CASTI, John: "Paradigm lost". Avon Books, New York, 1989
- CASTI, John: "Searching for Certainty". Morrow, New York, 1990
- CASTI, John: "Complexification". Harper-Collins, New York, 1994
- CASTI, John: "Bell Curves and Monkey Language" - Complexity, Vol.1, Nr.1, 1995
- CASTI, J. & KARLQVIST, A.: "Boundaries and barriers: on the limits to scientific knowledge"- Addison Wesley, New York, 1996
- CASTI, John: "Can you trust it: On the Reliability of Computer Simulation and the Validity of Models" - Complexity, Vol. 2, Nr.5, 1997
- CASTI, John: "The meme is the message". New Scientist, nr.2072, March 8, 1997
- CASTI, John: "Easy does it" - N.Sc., Nr. 2133, May 9th., 1998
- CASTRO LASZLO, Kathia: "Learning, design and action: creating the conditions for evolutionary learning community". SRBVS, 18(5), sept.-oct. 2001
- CATALANO, J.: "Thinking matter: consciousness from Aristotle to Putnam and Sartre"- Routledge, London, 2000
- CATTON, William R. Jr.: "Overshoot: the ecological basis of revolutionary change"- Univ. of Illinois Press, Urbana, IL, 1980
- CAUDILL, Maureen: "In our own Image: Building an artificial person". Oxford Univ. Press, New York, 1992
- CAVALLO, R.E. & KLIR, G.J.: "A conceptual foundation for problem solving". Intern. J. of Syst. Sciences, 8, 1977
- CAVALLO, Roger E.: "General Systems methodology and social sciences research". M. Nijhoff, Leiden, 1978
- CAVALLO, R.E. & KLIR, G.J.: "Reconstructability analysis of multi-dimensional relations". Intern. J. Gen. Systems, 5 (3) 1979
- CAVALLO, Roger E.: "Systems Research Movement". SGRS Bul., 9, nr.3, 1979
- CAWS, Peter: "Science and system: on the unity and diversity of scientific theory". SGRS Yearbook, 13, 1968
- CECCATO, S.: "La terza cybernetica". Feltrinelli, Milano, 1974
- CEES, Ahaus & van de WATER, Henny: "On responsibility and authority". Syst. Research, 11 (4), 1994
- CEREJIDO, Marcelino: "Orden, Equilibrio y Desequilibrio". Nueva Imagen, Mexico, 1978
- CERISY (Colloque de): "L'Auto-organisation: De la physique au politique" - Le Seuil, Paris, 1983
- CERUTI, Mauro: "Constraints and possibilities; evolution of knowledge and knowledge of evolution" - Gordon & Breach, Singapore, 1994
- CHABERT, J.L. & DALMEDICO, A.D.: "Henri Poincaré, le précurseur". La Recherche, n°232, mai 1991
- CHAITIN, Gregory: "Randomness and mathematical proof". Sc. American, 232 (5) 1975
- CHAITIN, Gregory: "Algorithmic information theory". Cambridge Univ. Press, 1987
- CHAITIN, Gregory: "Information, randomness and incompleteness" World Scientific, Singapore, 1987
- CHAITIN, Gregory: "A Random Walk in Arithmetic". New Scientist, March 24, 1990
- CHAITIN, Gregory: "The limits of mathematics" - Springer, Singapore, 1997
- CHALMERS, Rachel: "Surf like a Bushman"(foraging theory) - N.Sc., Nr. 2264. Nov. 11, 2000
- CHAMBADAL, Lucien: "Dictionnaire des Mathématiques Modernes". Larousse, Paris, 1969
- CHAMPION, D. & STOWELL, F.A.: "Validity action research field studies"- SPAR, 16(1), 2003
- CHANDLER, Jerry L.R.: "Computing anticipatory systems: a generic structure of organization"- CASYS J., 2, Inst. of Math., Univ. of Liège, Belgium, 1998
- CHANDLER, Jerry L.R.: "Semiotics of complex systems: a hierarchical notation for the mathematical structure of a single cell" in Holcombe, M. & Paton, R.C.(eds.): Information Processing in cells and tissues- Plenum Press, New York, 1998
- CHANDLER, William J.: "The science of history: A scientific, cybernetic approach". Gordon & Breach, New York, 1984
- CHAN-GEN BAHG: "Major systems theories through the world". Behav. Science, 35 (2) 1990
- CHANGEUX, Jean Pierre: "Neuronal man" - Princeton Univ. Press, 1994 (Original in French: "L'Homme neuronal")
- CHANGEUX, Jean P.: "Le cerveau et l'événement". Communications, n°18. Le Seuil, Paris, 1972
- CHANGEUX, J.P. & CONNES, A.: "Matière à réflexion" - Odile Jacob, Paris, 1989
- CHANGEUX, J.P. & CONNES, A.: "Matière à penser". - O. Jacob, Paris, 1989 (transl.german: Springer, Berlin; transl. spanish: Tusquets, Barcelona)
- CHANGEUX, Jean P.: "Les Neurones de la Raison". La Recherche, n°244, juin 1992
- CHANTEMARGUE, F. et al.: "Autonomous agents: from concepts to implementation"- Proceed. 14th Meet. on Cybernetics and Systems, Vienna, 1998
- CHAVENTRE, A. et JACQUARD, A.: "Un "isolat" du Sud Sahara: les Kel Kummer". Population, 29, 1974
- CHECKLAND, Peter B.: "Toward a system-based methodology for real world problem-solving". J. of Syst. Engin. 3/2, 1972
- CHECKLAND, Peter: "Systemic, not Systematic"- J. of Applied Systems Analysis, Vol.3, Nr.2 - Lancaster, 1972
- CHECKLAND, Peter B.: "Science and the Systems Paradigm". Intern. J. Gen. Systems, 3 (2) 1976
- CHECKLAND, Peter: "The Systems Movement and the Failure of Management Science" - C & S, Nr.11, 1980
- CHECKLAND, Peter B.: "Systems thinking, systems practice". Wiley, New York, 1981
- CHECKLAND, P. & DAVIES, L.: "The use of the term "Weltanschauung" in Soft Systems Methodology" - J.Appl.Syst.Anal., Vol..3, 1986
- CHECKLAND, Peter: "The case for "Holon" "- Systems Practice, 1, 1988
- CHECKLAND, Peter & SCHOLLES, Jim: "Soft Systems Methodology in Action". J. Wiley, Chichester, 1990
- CHECKLAND, Peter B.: "Model validation in Soft Systems Practice". Syst. Research, 12 (1) 1995
- CHECKLAND, Peter & HOWELL, Sue: "Information, Systems and Information Systems: Making sense of the field" - Wiley, Chichester, England, 1998
- CHECKLAND, Peter: "Emergent properties of SSM in use: a symposium by Reflective Practitioners"- SPAR, 13(6) 2000
- CHECKLAND, Peter: "New maps of knowledge"- SRBVS, 17(1), 2000
- CHECKLAND, Peter: "Soft systems methodology: a thirty years retrospective"- SRBVS, 17(5), 2000
- CHERRY, Colin: "On Human Communication". Wiley, New York, 1957
- CHISHOLM, Michael: "Human Geography" - Penguin Books, Harmondsworth, Middlesex, 1975
- CHISHOLM, R.F.: "Developing network organizations"- Addison Wesley, Reading, MA, 1998
- CHOMSKY, Noam: "Syntactic structures" - Mouton, The Hague, 1957
- CHOMSKY, Noam: "Language and Mind". Harcourt Brace & World, New York, 1969
- CHOMSKY, Noam: "Rules and Representations" - Columbia Univ. Press, New York, 1980
- CHORLEY, R.J. & KENNEDY, B. A.: "Physical Geography: A systems approach". Prentice Hall, Englewood Cliffs, 1971
- CHOWN, Marcus: "A Pattern emerges" - N.Sc., nr. 2090, July 12th, 1997
- CHOWN, Marcus: "Random Reality" - N.Sc., nr. 2227, February 26th, 2000
- CHRISTAKIS, Alexander N.: "A new policy science paradigm". Futures 5 (6) 1973
- CHRISTAKIS, Alexander N. & JESSEN, Peter J.: "Policy planning for humankind". Fields within Fields, nr. 11, 1974
- CHRISTAKIS, A.N. et al.: "Synthesis in a new age: A role for systems scientists in the age of design". Syst. Research, 5 (2), 1988

- CHRISTAKIS, Alexander: "The inevitability of demosophia" – in Tsivacou, I.(ed.): A challenge for systems thinking. Univ. of the Aegean Press, Athens, Greece, 1993
- CHRISTAKIS, Alexander: "Cogniscope conversation: some lessons learned in the Arena"- Plenum Press, New York, 2002
- CHRISTAKIS, A. & BRAHMS, S.: "Boundary spanning dialogue for the 21st Century Agora"- SRBVS, 20(4) 2003
- CHRISTALLER, W.: "Die zentralen Orte in Süddeutschland". Jena, 1933
- CHRISTALLER, W.: "Die ländliche Siedlungsweise in Deutschen Reich". Stuttgart, 1937
- CHRISTENSEN, W.D. & HOOKER, C.A.: "Anticipation in autonomous systems; foundations for a theory of embodied agents" – CASYS., Vol.5, Univ. Liège, 2000
- CHRISTIE, Maureen: "The ozone layer: a philosophy of science perspective".- Cambridge Univ. Press, Mass., 2001
- CHROUST, Gerhard: "Virtuality and transparency"- Systems 5(1/2), Polytechnical University, Wrocław, Poland, 2000
- CHROUST, Gerhard: "Motivational issues in component based software development"- Proc. 16th meeting on Cybernetics and Systems"- Vienna, 2002.
- CHURCHLAND, Patricia: "Matter and consciousness" – MIT Press, Cambridge, MA, 1984
- CHURCHLAND, Patricia: "Neurophilosophy: Toward a Unified Science of the Mind Brain". MIT Press, Cambridge, Mass., 1986
- CHURCHLAND, P.S. & SEINOWSKI, T.J.: "The computational brain" – MIT Press, Cambridge, Mass., 1992
- CHURCHLAND, P.M.: "The engine of reasoning, the sea of the soul: a philosophical journey into the brain" – MIT Press, Cambridge, Mass., 1995
- CHURCHMAN, C. West: "Theory of experimental inference". Mac Millan, New York, 1948
- CHURCHMAN, C. West: "An approach to General Systems Theory", in Mihailovic, M. (ed.) "Views on General Systems Theory". R. Krieger, Huntington, New York, 1963
- CHURCHMAN, C. West: "Challenge to reason". Mc Graw Hill, New York, 1968
- CHURCHMAN, C. West: "The systems approach". Dell Publ. Co., New York, 1968
- CHURCHMAN, C. West: "The design of inquiring systems". Basic Books, New York, 1971
- CHURCHMAN, C. West: "The systems approach and its enemies". Basic Books, New York, 1979
- CHURCHMAN, C. West: "An appreciation of E.A. Singer Jr.: the first Singer lecture". Soc. Syst. Science. Dpt., Univ. Pennsylvania, Philadelphia, 1981
- CHURCHMAN, C. West: "Thought and wisdom". Inter-systems, Seaside, Ca, 1982
- CHURCHMAN, C.W.: "Qu'est-ce que l'analyse par les systèmes?" – Dunod, Paris, 1974
- CICOGLA, G.: "Symmetry breakdown from Bifurcation" – Lettere al Nuovo Cimento, 31, 1981
- CIMATI, Felice: "Mente e linguaggio negli animali: Introduzione alla zoosemiotica cognitiva" – Carocci Ed., Roma, 1998
- CIPOLLA, Carlo M.: "La explosión demográfica". Salvat, Barcelona, 1973
- CLARK, A. : "Being there: Putting brain, body and world together again" – MIT Press, Cambridge, MA, 1999
- CLARK, Jere W.: "General Ecology and Knowledge in Curriculums in the Future", in E. Laszlo (ed.): "The Relevance of G.S. Theory". Braziller, New York, 1972
- CLAYTON, Nicole S.: "L'Apprentissage du chant chez les Oiseaux". La Recherche, n° 231, avr. 91
- CLEMENTSON, Anthony: "Strategy and uncertainty: a practical guide to systems thinking". Gordon & Breach, New York, 1988
- CLEMONSON, Barry: "Cybernetics: A new management tool". Abacus, Tunbridge Wells, 1984
- CLEREMANS, Axel: "Sur les traces de la conscience" – Interview in Athena, nr. 164, October 2000, Namur, Belgium
- CLOETE, A. & JAROS, G.: "The Biomatrix: Optimization and efficiency of teleons", in G. Lasker (ed): "Adv. in Systems Research and Cybernetics". Univ. of Windsor, Ontario, Canada 1988
- COATES, Joseph F.: "A futurist look at Systems science". Syst. Research, 12 (2) 1995
- COATES, Joseph: "Technological forecasting and social change"- Elsevier, New York, 1995
- COGLAN, David: "Interlevel dynamics in systemic action research"- SPAR, 15(4), 2002
- COHEN, David: "All the world is net" – N. Sc., nr.2338, April 13, 2002
- COHEN, J. & STEWART, I.: "The collapse of chaos: Discovering simplicity in a complex world" – Viking, New York, 1994
- COHEN, Philip: "Mice unwind the Body Clock" – N.Sc., Nr.2083, 24 May 1997
- COLE, M. : "Cultural psychology: a once and future discipline" – Harvard Univ. Press, Cambridge, Mass., 1996
- COLINVAUX, Paul A.: "Introduction to ecology"- Wiley, New York, 1973
- COLLEN, Arne: "Methodological perspectives on human systems, design and learning for a more global ethic". Cybernetics & Systems Research, World Scientific, Singapore, 1992
- COLLEN, Arne et al.: "Logical openness in systems". Syst. Research, 11 (2) 1994
- COLLEN, Arne, MINATI, G. & CIAPESSONI, E.: "Logical Openness in Systems" – Systems Research, Vol.11, Nr.2, 1994
- COLLEN, Arne & GASPARSKI, Wojciech W.: "Design and Systems. - Transaction Publishers, New Brunswick, New Jersey (U.S.A.) or London, 1995
- COLLEN, Arne: "Needed: a methodology for studying the interface and integration of communication processing systems?"- Systems, Wrocław, Poland, 1996
- COLLEN, Arne: "Sustaining conversation in human systems inquiry: the methodological perspective"- Proc. 42nd ISSS Conf., Atlanta, 1998
- COLLEN, Arne: "A conversation design for systemic research on and betterment of the ethicality of information systems embedded in human organizations"- Systems, 4 (1/2) Technological University, Wrocław, Poland, 1999
- COLLINS, HARRY: "Will machines ever think?". New Scientist, nr. 1826 June.20, 1992
- COLLINS, James P. et al.: "A New Urban Ecology" – Amer. Sc., Vol. 88, Nr.5, September 2000
- COMBES, Monique: "Quatre modes de représentation des organisations"- Rev. Internat. de Systémique, 11(3) 1997
- COMBS, Allan: "Cooperation: beyond the age of competition"- Gordon & Breach, Singapore, 1992
- COMBS, Allan: "The radiance of being: complexity, chaos and the evolution of consciousness" – Paradigm House, St.Paul, MN.,1995
- COMBS, A. & BRIER, S.: "Signs, information and consciousness" – Systems, 5 (1/2), Polytechnical University, Wrocław, Poland, 2000
- COMBS, Allan: "Embodied minds, second order cybernetic bodies"- C&HK, 9(1) 2002
- COMMINS, S. & LINSKOTT, R.N.: "The philosophers of science". Random House, New York, 1947
- CONANT, Roger & ASHBY, W.R.: "Every good regulator of a system must be a model of that system". Inter. J. of Syst. Science, I, 1970
- CONANT, Roger C.: "Detecting subsystems of a complex system". IEEE Transact. of Syst., Man & Cyb., 1972
- CONANT, Roger C.: "Information flows in Hierarchical Systems" Intern. J. Gen. Systems, 1 (1) 1974
- CONNELLY, Robert & BACK, Allen: "Mathematics and Tensegrity" – American Scientist, V.86, Nr.2, 1998
- CONRAD, Michael: "Adaptability"- Plenum Press, New York, 1983
- CONRAD, Michael: "Emergent computation through self-assembly"- Nanobiology, 2, 1993
- CONRAD, Michael: "Anti-entropy and the origin of initial conditions"- Chaos, solitons and fractals, nr.7, 1996
- CONRAD, Michael: "Physical-biological roots of information processing"- C&HK, 5(4), 1998
- CONSTANZA, Robert: "Embodied energy, energy analysis and economics" in Daly, H. & Umuna, A.(eds.): "Energy, economics and the environment". Westview, Press, Boulder, 1981
- CONTE, R. & CASTELFRANCHI, C.: "Cognitive and social action"- UCL Press, London, 1995
- CONWAY, John H.: "On numbers and games"- Academic Press, New York, 1976
- COOK, N.D.: "Stability and flexibility: An analysis of natural systems". Pergamon, Oxford, 1979
- COOMBS, M. & SULCOSKI, M.: "Control mechanisms for complex systems" – Univ. of New Mexico Press, Albuquerque NM, 1997
- COPELAND, B. Jack & PROUDFOOT, Diane: "Alan Turing's forgotten Ideas in Computer Science" – S.Amer., April 1999
- CORBALLIS, Michael C.: "The gestural Origins of Language"- Amer. Sc., Vol.87, Nr.2, 1999
- CORBARA, B. & DROGOUL, A.: "Emergence de l'organisation sociale chez les fourmis". Proc. 2nd. Eur. Congr. Syst. Science, Praha, 1993
- CORNELIS, Arnold: "The idea of a transcultural plateau", in de Zeeuw, G.(ed.): "Knowledge disappearance". Systeem Groep Nederland, Delft Univ. Press, 1986
- CORNING, Peter A.: "The Synergism Hypothesis: A Theory of Progressive Evolution" – Mc Graw Hill, New York, 1983
- CORNING, Peter: "Synergy and self-organization in the evolution of complex systems". Syst. Research, 12 (2) 1995

- CORNING, Peter A.: "Synergy, Cybernetics and the Evolution of Politics" - Intern. Political Science Review, Vol. 17, Nr.1, p.91-119, 1996
- CORNING, Peter A.: "Holistic Darwinism: Synergistic Selection and the Evolutionary Process" - J. of Social and Evolutionary Systems, Vol. 20, p.363-401, 1997
- CORNING, Peter A & KLINE, S.J.: "Thermodynamics, Information and Life revisited, Part one: To be or Entropy" - SRBVS, Vol.15, Nr.4, 1998a
- CORNING, Peter A & KLINE, S.J.: "Thermodynamics, Information and Life revisited, Part two: Thermoeconomics and Control Information" - SRBVS, Vol.15, Nr.5, 1998b
- CORNING, Peter A.: "Control information: a meaningful alternative to information theory" - Proc. 42nd. ISSS Conference, Atlanta, 1998
- CORNING, Peter A.: "Synergy: Another Idea whose Time has come?" - J. of Social and Evolutionary Systems, Vol. 21, Nr.1, 1998a
- CORNING, Peter A.: "The Synergism Hypothesis: On the Concept of Synergy and its role in the Evolution of Complex Systems" - J. of Social and Evolutionary Systems, Vol. 21, Nr.2, 1998b
- CORNING, Peter A.: "Devolution" as an opportunity to test the "synergism hypothesis" and the cybernetic theory of political systems" - SRBVS, 19(1), 2002
- CORNING, Peter A.: "Nature's magic: synergy in evolution and the fate of mankind" - Cambridge Univ. Press, Cambridge, MA, 2003
- COSTA, James, T.: "Caterpillars as Social Insects" - Amer. Sc., V.85 (2), 1997
- COTTERILL, R.M.J.: "Evolution, cognition and consciousness" - J. Consciousness Studies, 8 (2), 2001
- COTTERMAN, W.W. & SENN, J.A. (Eds.): Challenges and strategies for research in systems development" - Wiley, Chichester, 1992
- COTTRELL, Fred: "Energy and Society" - McGraw Hill, New York, 1955
- COUFFIGNAL, Louis: "La mécanique comparée". Thalès, Paris, 1951
- COULTER, N.A.(Jr.): "Toward a theory of teleogenetic control" - SGSR Yearbook, 1968
- COULTER, N.A.(Jr.): "Analysis of Brain Software: A Cybernetic Approach". ASC Cyb. Forum, 8, (1/2) 1976
- COULTER, N.A.(Jr.): "Can War be abolished?" ASC Cyb. Forum, 9 (1/2) 1979
- COUNELIS, J.S.: "Information and the unity of General Systems Theory and Cybernetics". Kybernetes, 8 (1), (p.25-32), 1979
- COUNELIS, James S.: "Generic design in the study of education: a systemic typology" - SRBVS, 17(1) 2000
- COUPLAND, N., FILES, H. & WIEMANN, J.M. (Eds.): "Miscommunications and problematic talk" - Sage, Newbury Park, 1991
- COUSSOT, Philippe & PIAU, Jean-Michel: "L'écoulement des boues". La Recherche, n° 258, 1993
- COVENEY, Peter: "L'irréversibilité du temps". La Recherche, nr.190, 1989
- COVENEY, Peter & HIGHFIELD, Roger: "The Arrow of Time". Flamingo, Harper & Collins, London, 1991
- COVENEY, P. & HIGHFIELD, R.: "Frontiers of complexity: the search for order in a chaotic world" - Faber & Faber, London, 1995
- COWAN, G., PINES, D. & MELTZER, D.(eds.): "Complexity metaphors, models and reality" - Addison Wesley, Reading, Mass., 1994
- COWAN, J.D.: "The problem of organismic reliability", in Wiener, N. & Schade. J. "Progress in brain research v.17: Cybernetics and the nervous system". Elsevier Publ., Amsterdam, 1965
- CRAIB, I.: "Modern social theory: from Parsons to Habermas" - Harvester Wheatsheaf, Hemel Hempstead, 1992
- CRICK, F. & KOCH, Chr.: "The problem of consciousness" - Sc. American, 267 (3) 1992
- CRILLY, A.J., EARSHAW, R.A. & JONES, H.: "Fractals and Chaos" - Springer, New York, 1991
- CRISTOFRE M. & GORDON, R.: "The evolution of perception" - Proc. 15th Cyb. & Syst. Meet., Austr.Soc.-Cyb.Stud., Vienna, 2000
- CROQUETTE, Vincent: "Déterminisme et Chaos" in "L'ordre du Chaos" Pour la Science. Diffusion Belin, Paris, 1989
- CROSS, Michael: "The truth is out there" - N.Sc., Nr.2226, February 2000 (about the need and difficulty to think about thinking)
- CROWLEY, D. & MITCHELL, D. (eds.): "Communication theory today" - Stanford Univ. Press, Stanford, CA, 1994
- CROZIER, Michel et FRIEDBERG, Ehrhard: "L'acteur et le système" - Seuil, Paris, 1977
- CRUTCHFIELD, J. et al.: "Le Chaos", in "L'ordre du Chaos" Pour la Science. Diffusion Belin, Paris, 1989
- CSANYI, Vilmos: "General theory of evolution". Academia KIADO, Budapest, 1982
- CSANYI, Vilmos & KAMPIS, György: "Autogenesis: The evolution of replicative systems". J. Theor. Biology, 114, (p.303-23) 1985
- CSANYI, Vilmos: "The replicative model of self-organization" in G.J. Dalenoort (ed): "The paradigm of self-organization" Gordon & Breach, New York, 1989
- CSANYI, Vilmos: "Evolutionary systems and society" - Duke Univ. Press, London, 1989
- CSANYI, Vilmos: "Culture and society as a replicative system", in Banathy, B. & Rodriguez Delgado, R.(eds.): Intern. Syst. Sc. Handbook, Systemic Publ., Madrid, 1993
- CUBE, Felix von & GUNZENHAUSER, Rul: "Über die Entropie von Gruppen". Schelle, Quickborn, 1967
- CUBE, Felix von: "Was ist Kybernetik?". Schunemann Verlag, Bremen, 1967
- CUBE, Felix von: "Kybernetische Grundlagen des Lernens und Lehrens". Klett, Stuttgart, 1968
- CUBE, Felix von: "Technik des Lebendigen: Methoden der Kybernetik". Rowohlt, Hamburg, 1970
- CULIK, K. & LINDENMAYER, A.: "Parallel graph generating and Graph Recurrence Systems for Multicellular Development". Intern. J. Gen. Systems, 3 (1) 1978
- CUMMINGS, L.L. & STRAW, B.M. (Eds.): "Information and Cognition in Organizations" - JAI, Greenwich, Conn., 1990
- CUNNINGHAM, D.J.: "Cognition as semiosis: the role of inference" - Theory and Psychology, 8, 1998
- CURRIE, W. & GALLIERS, B.: "Rethinking management information systems" - Oxford Univ. Press, 1999
- CUVIER, Georges: "Recherches sur les ossements fossiles des quadrupèdes". Deterville, Paris, 1812
- CYTOWIC, R.E.: "Synesthesia, a union of the senses" - Springer Verlag, 1989
- CZIKO, Gary: "The things we do: using the lessons of Bernard and Darwin to understand the what, how and why of our behavior" - The MIT Press, 2000
- CZYZEWSKI, M. et al (eds.): "Ritual chaos; study on public discourse" - Krakow, Poland, 1997
- DABA, Dumitru: "La relation macroscopique-quantique vue d'une perspective systémique". Institut de la Méthode, Bienne, 1992
- DABA, Dumitru: "La relation spatiale discret-continu entre le réductionisme mathématique ("atomiste") et la perspective systémique". Institut de la Méthode, Bienne, 1994
- DAHAN DALMEDICO, A. et al.(eds.): "Chaos et déterminisme". Le Seuil, Paris, 1992
- DALCQ, Albert: "L'oeuf et son dynamisme organisateur" - Albin Michel, Paris, 1940
- DALENOORT, G.J. (ed): "The paradigm of self-organization" Gordon and Breach, New York, 1989
- DALKEY & HELMER: "An experimental application of the Delphi method to the use of experts". Manag. Science, april 1963
- DALY, Herman: "Toward a steady state economy". Freeman, San Francisco, 1973
- DAMASIO, Antonio R. & Hanna: "Brain and Language". Sc. American, 267 (3) 1992
- DAMASIO, A.R.: "Descartes's error: emotion, reason and the human brain" - Gosset/Putnam Press, New York, 1994
- DAMASIO, A.R.: "L'errore di Cartesio (orig. in english)". Adelphi, Milano, 1995
- DAMASIO, A.R.: "The feeling of what happens: body, emotion and the making of consciousness" - Vintage, London, 2000
- DANESI, M.: "Giambattista Vico and the cognitive science enterprise" - Peter Lang, New York, 1995
- DANESI, M.: "Layering theory and human abstract thinking" - C&HK, 8(3) 2001
- DASH, D.P.: "Improvement of co-ordination: re-scripting research for multi-agent environments" - SRBVS, 19 (2), 2002
- DAUTENHAHN, Kirsten: "Human cognition and social agent technology" - J. Benjamins Publ.Co., 2000
- DAUTENHAHN, K. & NUMAKA, C.(eds.): "Socially intelligent agent" - Appl. Artif. Intell. J., 1998-99
- DAVEY, B. & PRISTLEY, H.: "Introduction to lattices and order" - Cambridge Univ. Press, Cambridge, 1990
- DAVIDOR, Y.: "Genetic algorithms and robotics" - World Scientific, Singapore, London, 1991
- DAVIDSON, Clive: "I process, therefore I am". New Scientist, nr. 1866, March 27, 1993
- DAVIDSON, Eric & al: "Origin of the adult bilaterian body plans: Evolution of development regulatory mechanisms" - Science 270, 1329, 1995
- DAVIDSON, Eric H, PETERSON Kevin J. & CAMERON R. Andrew: "A l'origine des grands animaux: Ce que nous disent les gènes de l'embryon sur l'origine des formes animales" - La Recherche, nr. 296, mars 1997
- DAVIDSON, John: "The secret of the creative vacuum" (Man and the energy dance). C.V. Daniel, London, 1989
- DAVIDSON, Mark: "Uncommon sense: the life and thought of K.L. von Bertalanffy" - Tarcher, Los Angeles, 1983

- DAVIES, Linda J.: "How Soft Systems Methodology deals with complexity". *Transact. Instit. of Measur. and Control*, 10 930, 1988
- DAVIES, Linda: "Understanding the organizational culture". *Sistémica* 1 (1), Instit. Andino de Sist., Lima, Peru, 1990
- DAVIES, Linda: "On the reality of systems". *Syst. Pract.*, 5(6), 1992
- DAVIES, P.C.W.: "The physics of time asymmetry". *Surrey Univ. Press, Belfast*, 1974
- DAVIES, Paul: "Chaos frees the Universe". *New Scientist*, nr 1737, Oct. 6, 1990
- DAVIES, P. & GRIBBIN, J.: "The matter myth: Beyond chaos and complexity". *Penguin, Harmondsworth*, 1992
- DAVIS, Chris & WATERS, Sam: "Information, its dimensions and quality". *Proc. 42nd ISSS Conf., Atlanta*, 1998
- DAVIS, L.: "Handbook of Genetic Algorithms". *Van Nostrand Reinhold, New York*, 1991
- DAVIS, L.: "Handbook of Genetic Algorithms". *Int. Thomson Computer Press, London*, 1996
- DAVIS, M. (ed): "The undecidable". *Raven Press, New York*, 1965
- DAVIS, P.J. & HERSCH, R.: "Descartes Dream: The World According to Mathematics". *Houghton Mifflin, Boston*, 1986
- DAVYDOV, A.A.: "Theory of Harmony of Proportions and Functions in Social Systems". *Syst. Research*, 9 (2) 1992
- DAWKINS, Richard: "The Selfish Gene". *Paladin, London*, 1978
- DAWKINS, Richard: "The blind Watchmaker". *Longmans, London*, 1986
- DAY, Stephen: "Genes that control genes". *New Scientist*, nr. 1741, Nov. 3, 1990 (*Inside Science* nr.40)
- DEACON, Terrence W.: "The symbolic species: the co-evolution of language and the brain". *W.W.Norton, New York*, 1997
- DEACON, Terrence W.: "Circling back to an organism-centered behavioral biology". *Amer. Sc.* 89(1), Jan.-Feb.2001
- DEBECKE, J.: "Recent long waves theory: An evaluation". *Futures*, 13 (4), 1981
- DE BONO, Edward: "The Mechanism of Mind". *Penguin Books, Harmondsworth*, 1971
- DECHERT, Charles R.: "Integration and change in Political and International Systems", in *Milsum, J.(ed): "Purposive Feedback"*. *Pergamon, New York*, 1968
- DECLERIS, Michael: "Systems Governance". *Sakkoulas, Athens*, 1989
- DECLERIS, Michael: "The coming systematized state". *3ra. Escuela Europea de Sistemas, Universidad de Valencia, España*, 1994
- DECUGIS, Henri: "Le vieillissement du monde vivant". *Masson, Paris*, 1941
- DEDEURWAERDERE, Tom: "Neural networks and the brain: associative learning and/or self-organization?". *CASYS J.*, 1, *Inst. de Math., Univ. de Liège, Belgium*, 1998
- DE DUVE, Christian: "L'Evolution a un Sens", an interview by O.POSTEL VINAY - *La Recherche*, Nr. 286, 1996
- DEELEY, J.: "Basics of semiotics". *Indiana Univ.Press, Bloomington*, 1940
- DEFFEYES, Kenneth S.: "Hubbert's Peak: the impending world oil shortage". *Princeton Univ. Press, N.Y.*, 2001
- DEFFUANT, Guillaume: "L'autonomie est-elle création ou rupture d'une clôture?". (*Varela et Castoriadis*). *Rev. Internat. Systémique*, 11(5) 1997
- DE GUERRE, Donald W.: "The codetermination of cultural change over time". *SPAR*, 13(5) 2000
- DE JOUVENEL, Bertrand: "Le Pouvoir". *Hachette, Paris*, 1974
- DEKING, F.M.: "Fractals: dimensions non-entières et applications". *Masson, Paris*, 1987
- DELANEY, W. & VACCARI, E.: "Dynamic models and discrete event simulation". *Marcel Dekker, New York*, 1989
- DELATTRE, Pierre: "Système, structure, fonction, évolution". *Maloine-Doin, Paris*, 1971
- DELATTRE, Pierre: "Concepts de formalisation et concepts d'exploration". *Scientia* n° 5-8, 1974
- DELATTRE, Pierre: "Systems Approach of Theoretical Models in Radiobiology and Radiotherapy". *Intern. J. Gen. Systems*, 1 (2) 1974
- DELATTRE, Pierre: "Elaboration et justification des modèles". *Maloine Doin, Paris*, 1979
- DELAYE, C. & CORBARA, B.: "De l'agent au super-agent: création de l'individualité à partir de mécanismes coopératifs". *Proc. 2nd. Europ. Congr. Syst. Science, Praha*, 1993
- DELGADO, G.: "Métodos y técnicas cualitativas de investigación en ciencias sociales". *Síntesis, Madrid*, 1994
- DELGADO, J.M.R.: "Unidad biológica de cerebro y mente". *Rev. Intern.de Sistemas* 3 (3) 1991
- DELGADO, J.M.R.: "Biological Unity of Brain and Mind: a Concept for Systems Education", in B. Banathy & R. Rodriguez Delgado (eds): "Intern. Syst. Science Handbook". *Systemic Publ., Madrid*, 1993
- DELIEGE, Irène: "Perceiving similarities and differences in listening to a piece of music". *CASYS J.*, 4, *Inst. de Math., Univ. de Liège*, 1999
- DEMAILLY, A. & LE MOIGNE, J.L.(eds): "Sciences de l'intelligence, sciences de l'artificiel". *Presses Univ. de Lyon*, 1986
- DEMONGEOT, J. (eds): "Dynamical systems and cellular automata". *Academic Press, London*, 1985
- DENBIGH, K.G.: "A non-conversed function for organized systems", in KUBAT, L. & Zeman, J.(eds): "Entropy and information". *Elsevier, New York*, 1975
- DENEUBOURG, J.L. et al.: "Quand l'erreur alimente l'imagination d'une société: le cas des fourmis". *Nouvelles de la Science et des technologies, Paris*, 1984
- DENEUBOURG, J.L. et al.: "Swarm-made architecture". (see in *Varela, F. & Bourgine, P.(eds.)*, 1992)
- DENIS, M. & SABAH, G.(eds.): "Mental architectures: vertical and horizontal". *Presses Univ. de Grenoble, Grenoble*, 1993
- DENNETT, D.: "Consciousness explained". *Little & Brown, Boston*, 1991
- DENNETT, D.: "Darwin's dangerous idea". *Simon & Schuster, New York*, 1995
- DENNING, Peter: "Sparse distributed memory". *Amer-Scientist*, 77 (4) 1989
- DENNING, Peter: "Is thinking computable?". *Amer. Scientist*, 78 (2), 1990
- DENNING, Peter: "Modeling reality". *Amer. Scientist*, 78 (6), 1990
- DENNING, Peter: "Mutual Exclusion". *Amer. Scientist*, 79 (2) 1991
- DENNING, Peter: "Genetic Algorithms". *Amer. Scientist*, 80 (1) 1992
- DENNING, Peter: "Neural Networks". *Amer.Scientist*, 80 (5) 1992
- DENT, E. & UMPLEBY, S.A.: "Underlying assumptions of several traditions in systems science". *Proc. 14th Meet. on Cybernetics and Systems, Vienna*, 1998
- DENTON, M.: "Evolution, une théorie en crise". *Rondon, Paris*, 1988
- De PAULI-SCHIMANOVICH, Werner & WEIBEL, Peter: "Gödel, Ein mathematischer Mythos". *Hölder, Pichler, Tempsky Verlag, Wien*, 1997
- DEPEW, David: "The Baldwin effect: an archeology (Baldwin concept of evolution)". *C&HK*, 7(1), 2000
- DERRIDA, J.: "Speech and phenomena". *North Western University Press, Evanston*, 1973
- DESCARTES, René: "Discours de la Méthode". *Editions de Cluny, Paris*, 1937
- DESCARTES, René: "Discourse on Method", in *Commins, S & Linscott, R.N.*: "The Philosophers of Science". *Random House, New York*, 1947
- DESTOUCHES, J.L.: "Basic concepts of Systems theory". *Cyb. & Systems*, 11 (3) 1980
- DESTOUCHES, J.L.: "Systèmes, Modèles, Previsions". *Rev. Intern.de Systémique*, 4 (4) 1990
- DETCHEV, G.: "Basic characteristics of the cell as an optimal self-regulating system". *Rev. Biomath.*, V.7, nr.4, *Paris*, 1969
- DETRAIN, C., DENEUBOURG, J.L. & PASTEELS, J.M. (Eds.): "Information processing in social insects". *Birkhäuser, Basel*, 1999
- DEUTSCH, Karl W.: "On social communication and the Metropolis". *SGSR Yearbook*, 6, 1961
- DEUTSCH, Karl W.: "The nerves of government: models of political communication and control". *Free Press, New York*, 1963
- DEUTSCH, Karl W.: "Some quantitative constraints on value allocation in society and politics". *Behav. Science*, 11 (4) 1966
- DEUTSCH, Karl W.: "Toward a cybernetic model of man and society", in *Buckley, W. (ed.)*: "Modern systems research for the behavioral scientist". *Aldine, Chicago*, 1968
- DEVANEY, R.L.: "An Introduction to Chaotic Dynamical Systems". *Benjamin/ Cummings, Menlo Park, CA*, 1986
- DEVANEY, R.L.: "Chaotic bursts in nonlinear dynamic systems". *Science*, 235, 1987
- DEVOTO, Roberto: "Nuevas imágenes del mundo desarrolladas por la física de hoy". *GESI-AATGSC, Buenos Aires*, 1992
- DEVROYE, L.: "Non-uniform random variate generation". *Springer, New York*, 1985
- DE WAAL, Frans: "Good Natured: The Origins of Right and Wrong in Humans and other Animals". *Harvard Univ. Press, Cambridge, Massachusetts*, 1996.
- DEWDNEY, A.K.: "Photovores: Intelligent robots are constructed from castoffs". *Sc.American*, 267 (3) 1992
- DEWEY, Edward & DAKIN, Edwin: "Cycles: the science of prediction". *H. Holt & Co., New York*, 1950
- DEWITT Mc GARRY, Donna: "Perceiving the pattern of optimization in a family system". *SRBVS*, 19(5) 2002

- D'HOERAENE, Jacques: "La prévision par l'analyse des séries chronologiques". Dunod, Paris, 1970
- DIAMOND, Jared: "Easter's End" - Discover, Aug 1995.
- DIAMOND, J.M.: "Guns, Germs and Steel: the fates of human societies" - Norton, New York, 1997
- DIAMOND, M.: "Enriching Heredity: The Impact of the Environment on the Anatomy of the Brain" - The Free Press, New York, 1988
- DICKENS, W.T. & FLYNN, J.R.: "Great leap forward" - N. Sc. nr. 2287, Apr.21, 2001
- DICKS, Lynn: "All for one" - N.Sc., Nr. 2246, July 8th, 2000
- DIJKUM, C.van & WALLNER, F. (eds.): "Constructive realism in discussion" - Social Science Press, Utrecht, 1991
- DIJKUM, C., ZEEUW, G. de & GLANVILLE, R.(eds.): "Methodological explorations in constructive realism" - BKS, Southsea, 1998
- DILLON, John (ed): "Mental images, values and analysis". Intern. Syst. Institute, San Francisco, 1986
- DILLS, C.R. & ROMISZOWSKI, A.J. (eds.): "Instructional development paradigms" - Educational Technology Publ., Englewood Cliffs, NJ., 1997
- DILTNEY, Wilhelm: "Das Wesen der Philosophie" - Teubner, Leipzig, Berlin (1922-1938)
- DILTNEY, Wilhelm: "Gesammelte Schriften" 9 vol. - Teubner, Leipzig, Berlin, 1922-1938)
- DINER, Simon: "Les voies du chaos déterministe dans l'Ecole russe", in Dahan Dalmedico, A. et al.(eds): Chaos et Déterminisme. Le Seuil, Paris, 1992
- DIRECTOR, S.W. & ROHRER, R.A.: "Introduction to systems theory". Mc.Graw Hill, New York, 1972
- DIRVEN, R. & VERSPOOR, M.: "Cognitive exploration of language and linguistics" - J. Benjamins, Amsterdam, 1998
- DIXON, N.: "The organizational cycle" - McGraw Hill, London, 1994
- DOBREMEZ, J.F. et al.: "Guerre chimique chez les végétaux" La Recherche 279, 1995
- DODDS, M.E. & JAROS, G.: "The name of the devil is sub-optimization". 38th Meet. ISSS, Asilomar, 1994
- DODDS, Martine: "Sustainable development- a systemic, evolutionary challenge"- 42nd Ann. Conf. ISSS, Atlanta, 1998
- DODDS, Martine: "Third generation systems thinking- Garajedaghi's integration of systems theory and practice"- 42nd Ann. Conf. ISSS, Atlanta, 1998
- DÖRNER, D.: "Die Logik des Misslingens" - Reinbek, 1988
- DOOYEWEERD, H.: "A new critique of theoretical thought" - Edw. Mellers Press, Lewiston, UK., 1997
- DOUADY, A.: "Déterminisme et indéterminisme dans un modèle mathématique", in Dahan Dalmedico, A. et al.(eds): "Chaos et déterminisme". Le Seuil, Paris, 1992
- DOUADY, S. et COUDER, Y.: "La physique des spirales végétales". La Recherche, 250, jan. 1993
- DOUGLAS, M. & HULL, D. (eds.): "How classification works" - Edinburgh Univ. Press, Edinburgh, 1992
- DOXIADIS, Constantinos A.: "Ekistics, an introduction to the science of human settlements" - Hutchinson, London, 1969
- DOXIADIS, Constantinos A.: "Ecology and ekistics" - Paul Elek, London, 1977
- DRAYE, J.P.: "Artificial neural networks and anticipatory systems"- CASYS J., 1, Univ. of Liège, Belgium, 1998
- DRAZIN, P.G.: "Nonlinear systems"- Cambridge University Press, 1992
- DRAZIN, P.G. & JOHNSON, R.S.: "Solitons, an introduction - Cambridge University Press, New York, 1996
- DRESS, A., HENDRIKS, H. und KÜPPERS, G.: "Selbstorganisation: Die Entstehung und Ordnung in Natur und Gesellschaft". Piper, München, 1986
- DRETSKE, F.: "Knowledge and the flow of information"- Blackwell, Oxford, 1981 (orig.in German)
- DRIESCH, Hans: "The science and philosophy of the organism" - Aberdeen Univ. Press, Aberdeen, 1908
- DROGOUL, A. & ZUCKER, J.D.: "Les premiers pas des robots sociaux" - La Recherche, nro. 350, fev.2002
- DROOGLEVER-FORTUIJN, L.: "Symbolic cerebral representation of the organism and its environment", in G. Lasker (ed): Adv. in Syst. Research and Cybernetics", Univ. of Windsor, Ontario, Canada, 1988
- DROZIN, V.G.: "Letter to the editor" ASC Cyb. Forum, V (4) 1973
- DROZIN, V.G.: "Complexology: the science of negentropy as a synthesis of GST and Cybernetics". ASC Cyb. Forum, VI (2) 1975
- DROZIN, V.G.: "The different meanings of cybernetics". ASC Cyb. Forum, VIII (1/2) 1976
- DRUCKER, Peter: "The age of discontinuity: guidelines to our changing society"- Transaction Publisher, London, 1992
- DUBOIS, Daniel: "L' intelligence artificielle et la logique du vivant". Cybernetica, 29 (3), 1986
- DUBOIS, Daniel: "Reformulation théorique et interprétation nouvelle de la loi sur la croissance de l'entropie". Cybernetica, 30 (2) 1987
- DUBOIS, Daniel & De RIJCKER-DANDOY, Nicole: "Reality and limits of learning in natural and artificial systems", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- DUBOIS, Daniel: "Le labyrinthe de l'intelligence". Academia, Louvain-La Neuve, Belgium, 1990
- DUBOIS, Daniel: "L'intelligence fractale". Athena, n°69, mars 1991
- DUBOIS, Daniel: "The fractal machine". Presses Univ., Liège, Belgium, 1992
- DUBOIS, D.M. & RESCONI, G.: "Hypercursivity, a new mathematical theory"- Presses Univ. de Liège, 1992
- DUBOIS, Daniel: "A semantic logic for CAST related to Zuse, Deutsch and McCulloch and Pitts computing principles". Proc. IFIP Workshop CAST and Computer Systems Technology, Innsbruck 1995 (Lecture notes in Computer Science, Springer Verlag, 1030, 1996)
- DUBOIS, Daniel M.: "Emergence of chaos in evolving Volterra Ecosystems" (In G. van de Vijver et al.(eds.) Evolutionary Systems - Kluwer, Dordrecht, 1998
- DUBOIS, Daniel M.: "Hyperincursive simulation of ecosystems chaos and patchiness by diffusive chaos"- CASYS J., 1, Univ. of Liège, Belgium, 1998
- DUBOIS, Daniel M.: "Introduction to computing anticipatory systems"- CASYS J., 2, Univ. of Liège, Belgium, 1998
- DUBOIS, Daniel M.: "Emergence of chaos, diffusive chaos and strange attractors in evolving Volterra ecosystems"- CASYS J., 3, Inst. de Math., Univ. de Liège, 1999
- DUBOIS, Daniel: "Incursive and hyperincursive systems, fractal machines and anticipatory logic"- CASYS Conf. 2000. Proc. Liège Univ., 2001
- DUBOIS, Daniel: "Theory of incursive synchronization of delayed systems"- 16th Meet. on Cybernetics and Systems, Vienna, 2002
- DUBOIS, Daniel M.(ed.): "Third Internat. Conf. CASYS'99 on Computing anticipatory Systems, Inst. of Math., Univ. of Liège, Belgium, 1999 (A very stimulating collections of original papers on Chaos)
- DUBOIS, Monique et al.: "L'ordre chaotique". La Recherche, n°185, fev.1987
- DUBUISSON, B.(ed): "Information and systems". Pergamon, New York, 1978
- DUDEK, Dionizy(ed.): "Prolegomena to the degradation of technical systems"- Systems 3(2), Polytechnical Univ. Wroclaw, Poland, 1998 (ed. of a special issue on Techn. Syst. (Degradation in general-contains a considerable bibliography on the subject, mainly in Polish)
- DUDLEY, Peter: "Back to basics? Tektology and General Systems theory". Syst. Practice, 9 (3) 1996
- DUDLEY, P. (ed.): "Bogdanov's tektology" - Centre for Systems Studies, Hull, UK., 1996
- DUDLEY, Robert: "Organismic design (on symmorphosis)" - Amer. Sc., 88(6) 2000
- DUFY, T.M. & JONASSEN, D.H.: "Constructivism and the technology of instruction" - L. Erlbaum, Hillsdale, NJ., 1992
- DUGATKIN, Lee Allan: "Cooperation among animals: an evolutionary perspective"- Oxford Univ. Press, New York, 1997
- DUGATKIN, Lee Allan: "Animals imitate, too" - Sc.Amer., October 2000
- DUGATKIN, Lee Allan: "The imitation factor: Evolution beyond the gene" - Free Press, Glencoe, 2001
- DUHL, Leonard: "Systems and services" - SRBVS, 19(5), 2002
- DUIJN, J.J.: "The long wave in economic life". Allen & Unwin, London, 1983
- DUMOUCHEL, A. & DUPUY, J.P. (eds): "L'auto-organisation". Le Seuil, Paris, 1983
- DUNCAN, R. & WESTON SMITH, M.(eds.): "The encyclopedia of ignorance". Wallaby, N.Y., 1978
- DURAND, Daniel: "La Systémique" - Que-Sais-je, Presses Univ. de France, Paris, 1979
- DURKIN, J.E. (ed): "General Systems Theory and group psychotherapy". Brunner Mazel, New York, 1978
- DUVIGNEAND, Paul: "La Synthèse écologique" - Doin, Paris, 1980
- DYER, Gordon: "Developing a family declaration of interdependence: System design within a small social unit". Syst. Research, 12 (3) 1995
- DYER, Gordon: "Exploring interdependence". Conversation paper, Asilomar, 1995
- DYER, Gordon: "Enthalpy: a metaphor for a design guide for conversations". Educat. Technol., jan. 1996
- DYLLICK, Thomas: "Management der Umweltbeziehung der Unternehmung"- Bern, 1988

- EARLS, John: "Cybernetics and Andean agriculture management". *Sistémica*, 1 (1), Instit. Andino de Sist., Lima, Peru, 1990
- EARMAN, J.: "A primer on determinism" - Reidel, Dordrecht, 1986
- EASON, K.: "Information technology and organizational change" - Taylor & Francis, London, 1988
- EASTON, David: "A framework for political analysis". Prentice Hall, Englewoods Cliffs, 1965a
- EASTON, David: "A systems analysis of political life". Wiley, New York, 1965b
- EBELING, W. & FEISTER, R.: "Physik der Selbstorganisation und Evolution". Akademie Verlag, Berlin, 1982
- EBELING, W., ENGEL, A. & FEISTER, R.: "Physik der Evolutionsprozess" - Akademie Verlag, Berlin, 1990
- EBELING, Werner.: "Chaos-Ordnung-Information" - Harri Deutsch Verlag, 1991
- EBELING, Werner: "Entropy and information in processes of self-organization: uncertainty and predictability" - *Physica A*, 19, 1993
- EBELING, W. et al.: "Komplexe Strukturen: entropic und information" - Teubner, Stuttgart, 1998
- EBERT, J. & SUSSEX, I.: "Interacting systems in development". Holt, Rinehart & Winston, New York, 1965
- ECCLES, John: "The understanding of the brain". McGraw Hill, New York, 1977
- ECCLES, John C.: "Evolution of the Brain: Creation of the Self" - Routledge, London, 1989
- ECCLES, John C.: "How the Self controls its brain". Springer Verlag, Berlin, 1994
- ECIMOVIC, T. et al.: "System thinking and climate change system" - Univ. of Maribor, Slovenia, 2002
- ECKARDT, B. von: "What is cognitive science?" - The MIT Press, Cambridge, 1995
- ECKERLSEY, R.: "Environmentalism and political Theory: Toward an ecocentric approach" - UCL Press, London, 1992
- ECKERT, Eberhard W.: "Structure and energy in the development process of society" - Proc. 42nd. ISSS Conference, Atlanta, 1998
- ECKMANN, Jean Pierre: "Mesures dans un système dynamique chaotique", in A. Dahan Dalmedico et al. (eds): "Chaos et Déterminisme". Le Seuil, Paris, 1992
- ECO, Humberto: "The limits of interpretation" - Indiana University Press, 1990
- ECO, Umberto: "Le Forme del Contenuto". Feltrinelli, Milano, 1971
- ECO, Umberto et al.: "Structuralism: An introduction". Clarendon Press, Oxford, 1973
- ECO, Umberto: "A theory of Semiotics". Indiana University Press, Bloomington, 1979
- ECO, Umberto: "Semiotics and the philosophy of language" - Indiana Univ. Press, Bloomington, 1984
- ECO, Umberto: "Kant and the platypus: essays on language and cognition" - Vintage, London, 1997
- ECONOMIDES, M. & OLIGNEY, R.: "The color of oil: history, money and politics of the world's biggest business" - Round Oak Publishing, Katy, TX., 2000
- ECONOMIST (The): "Machines with minds of their own" - The Economist Technology Quarterly, March 24, 2001
- EDDINGTON, Arthur: "The nature of physical world". Cambridge Univ. Press, 1929
- EDELMAN, Gerald M.: "Neural Darwinism": The theory of neuronal group selection" - Basic Books, New York, 1987
- EDELMAN, Gerald: "The Remembered Present: A Biological Theory of Consciousness" - Basic Books, New York, 1989
- EDELMAN, Gerald: "Bright Air, Brilliant Fire: On the Matter of Mind" - Basic Books, New York, 1992
- EDELMAN, G. & TONONI, G.: "A universe of consciousness; how matter becomes imagination" - Basic Books, New York, 2000
- EDELMAN, Gerald: "Pour une approche darwinienne du fonctionnement cérébral" - Interview en "La Recherche", nr.334, septembre 2000, Paris
- EDLUND, Bengt: "Categories and types of anticipation in music" - CASYS J. 4, Inst. de Math., Univ. de Liège, 1999
- EDMONDSON, A.: "A Fuller explanation" - Beckminster Fuller Institute, Sebastopol, CA., 1987
- EDWARDS, Anthony: "Venn diagrams for many sets". *New Scientist*, (1646) Jan. 7, 1989
- EDWARDS, Lawrence: "The vortex of life" - Floris Books, Edinburgh, UK, 1993
- EDWARDS, Rob: "Innocent bystanders" - *N.Sc.*, Nr.2163, Dec. 5th. 1998.
- EENWYCK, J. van: "Archetypes and strange attractors" - Inner City Books, Toronto, 1997
- EFRAN, J.S. et al.: "Language, structure and change: frameworks of meaning in psychotherapy" - W.W. Norton & Co., New York, London, 1990
- EFROS, A.: "Physics and geometry of disorder: Percolation theory". MIR Publ., Moscu, 1986
- EHRENFELS, Chr.von: "Über Gestaltqualitäten" - Viertel Jahreschrift für Wissenschaftliche Philosophie, Nr. 14, 1890
- EHRESMANN, A.C. & van BREMEERSCH, J.P.: "Modèle d'interaction dynamique entre un système complexe et des agents". *Rev. Intern. de Systémique* 3 (3), 1989
- EHRESMANN, A. C. & VAN BREMEERSCH, J.P.: "Information processing and symmetry breaking in memory evolutive systems" - *Biosystems*, 43, 1997
- EHRLICH, Paul R.: "Human Natures: Genes, Cultures and the Human Prospect" - Island Press, CA, 2000
- EIBEL-EIBESFELDT, Iräneus: "Wider die Misstrauensgesellschaft" - R. Piper, München, 1994
- EIGEN, M.: "Self organization of matter and the evolution of biological macromolecules". *Naturwissenschaften*, 58 (p.465-523), 1971
- EIGEN, M.: "The hypercycle: Principle of natural self-organization". *Naturwissenschaften*, 64, 1977
- EIGEN, M. & SCHUSTER, P.: "The Hypercycle". Springer Verlag, Berlin, 1979
- EIGEN, M. & WINKLER, R.: "Das Spiel". Pieper, München, 1975 (in English: "Laws of the game". Knopf, New York, 1981)
- EIGEN, Manfred: "Stufen zum Leben: Die Frühe Evolution im Vision der Molekularbiologie" - Pieper, München, 1987
- EIGEN, Manfred: "Steps towards life: a perspective on evolution". Oxford Univ. Press, 1992
- EIGEN, M. & OSWATITSCH, R.W.: "Steps toward life: a perspective on evolution" - Oxford Univ. Press, New York, 1992
- EISENHART, P., KURTH, D. & STIEHL, H.: "Du steigst nie zweimal in denselben Fluss: die Grenzen der wissenschaftlichen Erkenntnis" - Reinbek, 1988
- EKDAHL, Bertil: "Classification of anticipatory systems" - 1st. World Multi-conference on Syst., Cyb. & Inform., Caracas, 1997
- EKDAHL, Bertil: "Anticipatory Systems and Reductionism" - Proc. Cyb. & Syst. Conf. 2000- Austrian Soc. for Cyb. Studies, Vienna, 2000
- EKELAND, Ivar: "Le Calcul, l'imprévu". Le Seuil, Paris, 1984
- EKELAND, Ivar: "Mathematics and the Unexpected" - Univ. of Chicago Press, 1988
- ELDREDGE, N. & SALTHER, S.N.: "Hierarchy and Evolution" - in DAWKINS, R. & RIDLEY, M. (Eds): *Oxford Surveys in Evolutionary Biology*, Vol.1, Oxford Univ. Press, 1984
- ELDREDGE, Niles: "Time Frames: The Evolution of Punctuated Equilibrium" - Princeton Univ. Press, 1990
- ELDREDGE, N. & GOULD, Stephen: "Punctuated equilibrium; an alternative to phyletic gradualism", in T.J. Schopf (ed.) "Models in Paleontology"
- ELGIN, Duane: "The self-guiding evolution of civilizations" - *SRBVS*, 20(4) 2003
- ELIAS, Norbert: "Über den Prozess der Zivilisation" - Suhrkamp, Frankfurt a/M, 1969
- ELIAS, Norbert: "Über die Zeit" - Suhrkamp, Frankfurt a/M, 1984.
- ELIAS, Norbert: "Die Gesellschaft der Individuen" - Suhrkamp, Frankfurt a/M, 1987
- ELIAS, Norbert: "Menschen in Figuren: Ein Norbert Elias Lesebuch" - Uni Taschenbücher 1852, UTB, Leske & Budrich, Opladen, 1995
- ELLIS, Keith et al.: "Critical issues in systems theory and practice" - Plenum Press, New York, 1995
- ELLUL, Jacques: "The technological society" - Vintage Books, Random House, New York, 1964
- ELLUL, Jacques: "Le bluff technologique" - Hachette, Paris, 1988
- ELOHIM, J.L.: "System science: is it necessary?" - Proceed. 16th Meeting on Cybernetics and Systems, Vienna, 2002
- ELSASSER, W.M.: "Atom and organism: A new approach to theoretical biology". Princeton Univ. Press, 1966
- EMERY, F.E.(ed.): "Systems thinking". Penguin Books Ltd., Harmondsworth, Middlesex, 1969
- EMERY, Fred & TRIST, E.L.: "Toward a social ecology". Plenum Press, New York, 1975
- EMERY, F.E. (ed.): "Participative design for participative democracy" - Australian National University, Canberra, 1993
- EMERY, F.: (A SPAR special issue on his open systems theory) - *SPAR* 13(5) 2000
- EMERY, Merrelyn: "The current version of EMERY's open systems" - *SPAR*, 13 (5) 2000
- EMMECHE, C. & HOFFMEYER, J.: "From language to nature: the semiotic metaphor in biology" - *Semiotica* 84(1/2), 1991
- EMMECHE, Claus: "The Garden in the Machine: The emergent science of Artificial Life". Princeton Univ. Press, New Jersey, 1994 (Original in Danish)
- EMMECHE, C.: "Defining life as a semiotic phenomenon" - *C&HK*, 5, (1), 1998
- ENGELBERG, Joseph: "On Integrative study". *Syst. Research*, 9 (1) 1991

- ENGELHARD, Ph.: "L'homme mondial: les sociétés humaines peuvent-elles survivre?"- Arlea, Paris, 1996
- ENGLAND, Lynn: "Community and Autopoiesis"- Proceed. 16th Meeting on Cybernetics and Systems, Vienna, 2002
- ENGSTROM, Jack: "Precursors to laws of form in C.S. Peirce's collected papers"- C&HK, 8 (1-2), 2001
- ERCEAU, J. & FERBER, J.: "L'intelligence artificielle distribuée". La Recherche, n° 233, juin 1991
- ERICSON, Richard F.: "The Impact of Cybernetic Information Technology on Management Value System". SGSR Yearbook, 14, 1969
- ERICSON, R. (Ed.): "Improving the Human Condition: Quality and Stability in Social Systems"- Springer, London, 1979
- ERIKSSON, D.M.: "An exposition of Jean-Louis Le-moigne's systemic theory"- C&HK, 4(2/3), 1997
- ERIKSSON, D.M. & WULF, W.(eds.): "Self-organizing social systems: a challenge to computer supported cooperative work"- C&HK, 6(2), 1999
- ERWIN, Douglas, VALENTINE, James & JABLONSKI, David: "The Origine of Animal Body Plans" - Amer. Sc., V.85, (2), 1997.
- ESCOE, Kenneth: "The development of a sustainable system under uncertainty"- Proc. 42nd. ISSS Conf., Atlanta, 1998
- ESPAGNAT, Bernard d': "A la recherche du réel". Gauthier - Villars, Paris, 1979
- ESPAGNAT, Bernard d': "In search of reality"- Springer, New York, 1983 (french orig. "A la recherche du réel" - Gauthier Villars, Paris, 1979)
- ESPAGNAT, Bernard d': "Une incertaine Réalité". Gauthier - Villars, Paris, 1985
- ESPAGNAT, Bernard d': "Les nombres et l'essence des choses". La Recherche, n°282, 1995
- ESPEJO, Raul: "Information and management: the cybernetics of a small company". Univ. of Aston, Paper 125, Birmingham, 1979
- ESPEJO, Raul: "Seeing Complexity: the Cybernetic Viewpoint". Transact. Inst. of Measur. and Control, 10 (3) 1988
- ESPEJO, Raul & HARNDEN, Roger (eds): "The viable system model". Wiley, New York, 1989
- ESPEJO, Raul: "Complexity and change: Reflections upon the cybernetic intervention in Chile 1970-1973". Cyb. & Systems, 22 (4) 1991
- ESPEJO, R. & SCHWANINGER, M.: "Organizational fitness: corporate effectiveness through management cybernetics" - Campus Verlag, New York, 1993
- ESPEJO, R. et al.: "Organizational transformation and learning" - Wiley, Chichester, 1996
- ESPEJO, Raul et al: "Organizational Transformation and Learning" - Wiley, New York, 1996
- ESPEJO, Raul: "Self-construction and restricted conversations"- SRBVS, 14(3), 1997
- ESPEJO, R. & STEWART, N.D.: "Systemic reflections on environmental sustainability"- SRBVS, 15(6) 1998
- ESPEJO, Raul: "Self-construction of desirable social systems" - Kybernetes 29(7/8), 2000
- ESPOSITO, Joseph: "Remarks toward a General Theory of Organization". Intern. J. Gen. Systems, 2 (3) 1975
- ESTEP, Myrna L.: "On models and retroductive inference". Cybernetics & Systems Research 92, World Scientific, Singapore, 1992
- ESTEP, Myrna: "What Gödel said: on the non-algorithmic nature of the 2nd theorem"- Proceed. 14th Meeting on Cybernetics and Systems, Vienna, 1998
- EUGENE, Jacques: "Aspects de la théorie générale des systèmes". Maloine, Paris, 1981
- EVE, R., HORSFALL, S. & LEE, M. (eds.): "Chaos, complexity and sociology: myths, models and theories"- Thousand Oaks, Sage, CA., 1997
- FAIRLOUGH, Gerard H.: "Systems Practice from the start: Some experiences in a biotechnology company". Syst. Pract. 2 (4) 1989
- FALGER, V.S.E.: "De dierlijke mensbenadering" (in Dutch) (On human and animal ethology) - Systemica, 2, Utrecht, 1982
- FARGE, Marie: "Evolution des théories sur la turbulence développée", in Dahan Dalmedico, A. et al. (eds): "Chaos et déterminisme". Le Seuil, Paris, 1992
- FARMER, D., TOFFOLI, T. & WOLFRAM, S. (eds.) : "Cellular automata" - North Holland, New York, 1984
- FARRE, G.L.: "The semantic filter and the structure of observation" - 13th EMCSR Conference, Vienna, 1996
- FARRE, G.L.: "The energetic structure of observation"- Amer.Behav.Sc., 40, 1997
- FARRE, G.L.: "Emergence: its characteristics and limits"- 42nd. Annual Conference of the ISSS, Technology Institute, Atlanta, 1998a
- FARRE, G.L.: "On semantic filters"- CASYS J. , 2, Inst. de Math., Univ. de Liège, 1998b
- FARRE, G.L.: "The mind and its quantal substance"- CASYS J., 3, Inst. de Math., Univ. de Liège, 1999
- FARRE, G.L.: "A generic theory of evolution for natural systems".- Proc.15th Cyb. Syst. Meet., Austr.Soc.-Cyb.Stud., Vienna, 2000
- FARRE, G.L.: "The quantal architecture of natural systems" -CASYS J., 7, Inst.de Math., Univ. de Liège, 2000
- FARRE, G.L.: "The quantum theory of evolution : a sketch"- Proc. 16th Meeting on Cybernetics and Systems, Vienna, 2002
- FARRE, G.L.: "Cybernetics and Evolution" Proc. 14th cyb. and Syst. Meet., Vienna, 1998 c
- FARRELL, Chris: "Survival of the fittest technology". New Scientist, nr.1859, 1993
- FEIBLEMAN, J.K.: "Theory of integrative levels". Brit. J. Philosophy of Science, May 1954
- FEIBLEMAN, J. & FRIEND, J.W.: "The structure and function of organization". Philosophical Review, 54, 1945. (Also in F.E. Emery (ed.): "Systems thinking". Penguin, Harmondsworth, 1969
- FELL, L. & RUSSELL, D. (eds.): "Seized by agreement, swamped by understanding" - Drs.Fell, Russell & Ass., Glenbrook, 1994
- FELL, L. & RUSSELL, D.(eds.): "Towards a biological explanation of human understanding"- C&HK, 4(1), 1997
- FERBER, Jacques: "Multi-Agent systems: an introduction to distributed artificial intelligence" - Addison Wesley, Longman, 1999
- FERRER FIGUERAS, L. et al.: "Tercera Escuela Europea de Sistemas (A collection of 34 papers in English, French and Spanish) - Universitat de València, Spain, 1994
- FERRY, Georgina: "Parallel learning in brain and machines". New Scientist, nr.1499, 1986
- FESTINGER, L.: "A theory of Cognitive Dissonance". Stanford Univ. Press, Stanford, 1957
- FETZER, James H.: "Artificial intelligence: its scope and limits"- Kluwer, Dordrecht, 1990
- FEY, W. & WIMBERLY LAM, A.: "Pie in the sky: a systems dynamics perspective on sustainability"- 42nd. Ann.Conf. of the ISSS, Georgia Technology Institute, Atlanta, 1998
- FEYERABEND, P.: "Against method; outline of an anarchistic theory of knowledge"- New Left Books, London, 1975
- FEYERABEND, P.: "Farewell to reason"- Verso, London, 1987
- FIELD, Richard J.: "Chemical organization in time and space". Amer. Scientist, 73 (2), 1985
- FIESLER, Emile & BEALE, Russell (Eds.): "Handbook of Neural Computation" - Oxford University Press, New York, 1996
- FINNEMANN, Niels Ole: "On the notions of rule-generating and anticipatory systems"- CASYS J. 1, Inst. de Math., Univ. de Liège, 1998
- FIORRETTI, Guido: "A concept of complexity for the social sciences"- Rev. Intern. Systémique, 12 (3), 1998
- FISCHBACH, G.D.: "Mind and brain"- Sc.Amer., 267, 1992
- FISCHER, Roland: "On Dissipative Structures in both Physical and Information Space". ASC Cybernetics Forum, 8 (1/2) 1976
- FISCHER, Roland: "A Neurological Re-interpretation and Verification of Bosovich Covariance (1758)". Cybernetica, 34 (2) 1991
- FISCHER, Roland: "A Neuroepistemological View of Natural and Artificial Intelligence". Cybernetica, 35 (3) 1992
- FISKE, Philip H. & ROOT, W.: "Identification of slowly varying systems". Inf. & Control, 32 (3), 1976
- FIVAZ, Roland: "Thermodynamics of Complexity". Syst. Research, 8 (1) 1991
- FIVAZ, Roland: "Morphodynamics, ergodic theory of complex systems"- Syst. Research, 10, 1992
- FIVAZ, Roland: "The nature of order in complex systems". Syst. Research, 11 (3) 1994
- FIVAZ, Roland: "Ergodic Theory of Communication" - Syst. Research, Vol. 13, nr.2, 1996.
- FIVAZ, Roland: "Ergodic Theory of Communication". Syst. Research, 13 (2), 1996
- FIVAZ, Roland: "Time and interactions in complex systems"- SRBVS, 14(3), 1997
- FIVAZ, Roland: "Why consciousness? A causal account"- SRBVS, 17(6) 2000
- FIVAZ, Roland: "Unidimensional life"- SRBVS, 20(3) 2003
- FLAMENT, C.: "Théorie des graphes et structure sociale". Mouton, Paris, 1972
- FLECHTNER, Hans J.: "Grundbegriffe der Kybernetik", Hirzel, Stuttgart, 1972
- FLIEDNER, Dietrich: "Mankind as society, an example of a non-equilibrium system". Syst. Research, 9 (3), 1992
- FLOOD, Robert L.: "Complexity, a definition by construction of a conceptual framework". Syst. Research, 4 (3) 1987
- FLOOD, Robert L.(ed): "Management of complexity". Transact. Inst. of Measur. and Control, (special issue), 10 (3) 1988

- FLOOD, R. & KEYS, P.: "Methodology choice, complexity texture, self-reflection". *Cyb. & Systems*, 20 (5), 1989
- FLOOD, R.L. & ROBINSON, S.A.: "Thimbles and hope: An essay on analogy and systems theory". *Cyb. & Systems*, 20 (3), 1989
- FLOOD, Robert L.: "Liberating systems theory" - Plenum Press, New York, 1990
- FLOOD, R. & JACKSON, M.C.(eds): "Critical Systems Thinking: directed readings". Wiley, Chichester, U.K., 1991a
- FLOOD, R. & JACKSON, M.C.: "Creative problem solving: total system intervention". Wiley, Chichester, 1991b
- FLOOD, Robert L.: "Critical Systems Thinking and Total Systems Intervention". *Cyb. & Systems*, 22 (2), 1991
- FLOOD, R. & CARSON, E.R.: "Dealing with complexity: An introduction to the theory and applications of Systems science". Plenum Press, New York, 1988/1993
- FLOOD, Robert L.: "An improved version of the process of Total Systems Intervention (TSI)" - *Systems Practice*, 8, Nr.3, (1995)
- FLOOD, Robert L.: "Solving problem solving" - Wiley, Chichester, 1995
- FLOOD, R. & ROMM, N.: "Critical systems thinking: Current Research and Practice" - Wiley, Chichester, 1996
- FLOOD, R.L. & ROMM, N.: "Diversity management: triple loop learning" - Wiley, Chichester, 1996
- FLOOD, Robert: "Holism and the social action problem solving" - University of Hull, U.K., 1996
- FLOOD, Robert & ROMM, Norma: "A Typology of Power Supporting Intervention" - *Syst. Practice* 9 (4), 1996
- FLOOD, Robert L.: "Festschrift edition in celebration of Peter Checkland's 70th birthday" - *SPAR*, 13(6) 2000
- FLOOD, R. & JACKSON, M.: "Critical Systems Heuristics" - *Systems Practice*, Vol.4, Nr.4, 1991, d
- FLOOD, R. & JACKSON, M.: "Total System Intervention: A Practical Face to Critical Systems Thinking" - *Systems Practice*, Vol.4, Nr.3, 1991, c
- FLOOD, Robert L.: "Sustainability through global systems education" - *Proceed.42th ISSS Meeting*, Atlanta, 1998 b
- FLOOD, Robert: "Action research and the management and systems sciences" - *SPAR*, 11(1), 1998 a
- FLOOD, Robert: "A special issue on Interpretive Systemology, at Univ. of Los Andes, Merida, Venezuela" - *SPAR*, 12 (1) 1999 a
- FLOOD, Robert: "Knowing of the unknowable" - *SPAR*, 12 (3), 1999 b
- FLOOD, Robert: "Rethinking the fifth discipline: learning within the unknowable" - Routledge, London, 1999 c
- FLOREA, A.M. et al.: "Genetic prediction of a multi-agent environment evolution" - *CASYS Conf.* 2000, Proc. Univ. of Liège, 2001
- FLOREANO, Dario: "Manuale sulle reti neurale" - Ed. Il Mulino, Torino, 1996
- FLOREANO, Dario: "Darwin revisité par la sélection artificielle". - *La Recherche*, nro.350, fev.2002
- FLOREANO, Dario et al.: "L'évolution artificielle (a written symposium in successive deliveries) - Institut de la Méthode, Lausanne University, Switzerland, 2002-2003
- FLORES, Fernando: "Inventando la empresa del Siglo XXI" - Hachette, Santiago de Chile, 1989
- FLORKIN, Marcel: "L'évolution biochimique" - Masson, Paris, 1944
- FLOYD, Christiane et al.(eds.): "Software development and reality construction" - Springer Verlag, Berlin, Heidelberg, 1992
- FLOYD, Christiane: "Software development process: a constructivist epistemology point of view" - *C&HK*, 6(2)1999
- FODOR, J.A.: "Special sciences or the disunity of science as a working hypothesis". - *Synthese*, 28, 1974, p. 97-115
- FODOR, J.A. : "The language of thought" - MIT Press, Cambridge, Mass., 1975
- FODOR, J.: "The modularity of mind". MIT, Cambridge, Mass., 1983
- FODOR, J.A.: "Psychosemantics: the problem of meaning in the philosophy of mind". - A Bradford Book, MIT Press, Cambridge, Mass., 1987
- FODOR, Jerry: "The mind does work that way (i.e. a critique of Pinker's views)" - MIT Press, Cambridge, MA, 2000
- FOERSTER, Heinz von (ed): "Cybernetics". (1951-55) Josiah Macy Foundation, New York (1951-55)
- FOERSTER, Heinz von: "Some aspects in the design of biological computers". *Proc. 2nd. Intern. Congress of Cybernetics*, Namur, 1958
- FOERSTER, Heinz von et al.: "Doomsday, November 13, AD 2026". *Science*, 132, pp.1291-95, 1960
- FOERSTER, Heinz von: "On self-organizing systems and their environment", in Yovitz & Cameron (eds): "Self organizing systems". Pergamon, New York, 1960
- FOERSTER, Heinz von & ZOPF, G.V.(Eds): "Principles of self-organization". Pergamon, New York, 1962
- FOERSTER, Heinz von (ed): "Purposive systems". Spartan Books, Washington, 1968
- FOERSTER, Heinz von (ed): "Analysis and synthesis of cognitive processes and systems". Univ. of Illinois, Urbana, 1969
- FOERSTER, Heinz von: "Cybernetics at Illinois". *ASC Forum* 6 (2) 1974
- FOERSTER, Heinz von: "Cybernetics of Cybernetics". *ASC Forum* 6 (3) 1974
- FOERSTER, Heinz von: "Objects: Tokens for (Eigen) Behaviors". *ASC Cyb. Forum* 8 (3/4) 1976
- FOERSTER, Heinz von: "2nd order concepts: A parable of circular causality". *Proc. 21st SGSR Meeting*, 1977
- FOERSTER, Heinz von: "On Interaction, the Whole and its Parts". *Am. Soc.Cybern. Forum* 9 (3) 1979
- FOERSTER, Heinz von: "Observing Systems". *Intersystems Publ.*, Seaside, CA, 1981 (A collection of his papers)
- FOERSTER, Heinz von: "Sicht und Einsicht" - Vieweg, Braunschweig, 1985
- FOERSTER, Heinz von: "Lethology: a theory of learning and knowing vis-à-vis undeterminables, undecidables, unknowables". - *Paper Internat.Seminar "Conoscenza come educazione"* - Trento, Italy, 1990
- FOERSTER, Heinz von: "Las Semillas de la Cibernética. Obras escogidas por Marcelo PAKMAN" - Gedisa, Barcelona, 1991
- FOERSTER, Heinz von: "Entdecken oder Erfinden: Wie lässt sich Verstehen verstehen", in Watzlawick, P. (ed): "Einführung in den Konstruktivismus". Piper, München, 1992
- FOERSTER, Heinz von: "Gegenstände greifbare Symbole für (Eigen-)Verhalten", in *"Wissen und Gewissen. Versuch einer Brücke"* - Suhrkamp Verlag, Frankfurt am Main, 1993
- FOERSTER, H. von & BROCKER, M.: "Teil der Welt: Fraktale einer Ethik" - Ein drama in drei Akten" - (von Foerster wonderful personal history and his role in the development of 2nd. Order cybernetics)- Carl Auer, Systeme Verlag, Heidelberg, 2002
- FOGEL, D.B.: "Evolutionary computation: toward a new philosophy of machine intelligence" - IEEE Press, Piscataway, N.J., 1995
- FORD, D.H.: "Humans as self-constructing living systems" - Erlbaum, Hillsdale, N.J., 1987
- FORD, D.H. & LERNER, R.M.: "Developmental systems theory: an integrative approach" - Sage Publ., Newbury Park, CA, 1992
- FORD, Joseph: "Algorithmic Information Theory". (A review by G. CHAITIN). *Amer. Scientist*, 77 (6) 1989
- FOREST, Herman S.: "Anaerobic Leftovers" (a letter to the Editor). *Amer. Scientist*, 82 (3) 1994
- FORGET, Pierre-Michel: "Les forêts tropicales en sur-sis". *La Recherche*, nr.270, 1994
- FORGIONE, Giuseppe A.: "Providing Complete and Integrated Information Science Education". *Syst. Research.*, 9 (1) 1991
- FORREST, Jeffrey: (see YI-LIN)
- FORRESTER, Jay: "Industrial dynamics". MIT Press, Cambridge, Mass., 1961
- FORRESTER, Jay: "Urban dynamics". MIT Press, Cambridge, Mass. 1969
- FORRESTER, Jay: "World dynamics". Wright Allen Press, Cambridge, Mass., 1971
- FORRESTER, Jay: "Principles of Systems". 2nd ed. Wright Allen Press, Cambridge, Mass., 1973
- FORRESTER, Jay: "Nonlinearity in High Order Models of Social Systems". *Europ. J. Oper. Res.* 37, 1988
- FORRESTER, Jay: "Systems dynamics and the lessons of thirty five years", in K.B. De Greene (ed.): "A systems based approach to policy making". Kluwer, Boston, 1991
- FORSYTH, D. & KELLEY, K.: "What's social about social cognition" - Sage Publ., Thousand Oaks, CA, 1996
- FOSNOT, C.T. (ed.): "Constructivism: theory, perspectives and practice" - Teacher Coll. Press, Columbia Univ., 1996
- FOSTER, I. & KESSELMAN, C.: "The grid: blueprint for a new computing infrastructure" - Morgan Kaufmann Publ., San Mateo, CA., 1999
- FOUCAULT, Michel: "Madness and civilization" - Vintage Books, New York, 1965 (original work in french published 1961)
- FOUCAULT, Michel: "Les Mots et les Choses", Gallimard, Paris, 1966
- FOUCAULT, Michel: "The order of things" (R.D.Laing, trans)- Vintage Books, New York, 1973 (original work in french published 1966)

- FOUCAULT, Michel: "The Archeology of Knowledge" – Pantheon Books, New York, 1972 (original in french, 1969)
- FOUCAULT, Michel: "Discipline and punish" (A. Sheridan, trans) – Vintage Books, New York, 1979 (original work in french published 1975)
- FOUCAULT, Michel: "The Foucault reader" (R. Rabinow, ed. & trans) – Pantheon Books, New York, 1984
- FOUCAULT, Michel: "The care of the self" (R. Hurley, trans) – Vintage Books, New York, 1988 (original work in french published 1984)
- FOURASTIE, Jean: "Les conditions de l'esprit scientifique" – NRF, Paris, 1968
- FOUTS, R.S. & FOUTS, D.H.: "Chimpanzees' use of sign language" – In CAVALIERI, P. & SINGER, P.: "The great ape project" – St. Martin Press, New York, 1993
- FOX, Ronald F.: "Energy and the evolution of life". Freeman, San Francisco, 1988
- FOX, Sydney: "Self organizing phenomena and the first life". SGSR Yearbook, 5, 1960
- FOX KELLER, Evelyn: "The century of the gene" – Harvard U.P., 2000
- FRÄNDBERG, Tage: "Living systems: a study of its philosophical background" – 42nd Ann. Conf. of the ISSS, Georgia Technology Institute., Atlanta, 1998
- FRÄNDBERG, Tage: "Experiences of applying General Living Systems Theory" – SRBVS, Vol.16, Nr.1, 1999
- FRAISSE, Paul: "La psychologie du temps" – Presses Univ. de France, Paris, 1967
- FRAISSE, Paul: "La psychologie du rythme" – Presses Univ. de France, Paris, 1974
- FRANC, Alain & GOUYON, Pierre Henri: "Information et Complexité" – La Recherche Nr. 296, mars 1997
- FRANCIS, J.G.: "The politics of regulation: a comparative perspective" – Blackwell, Oxford, UK, 1993
- FRANÇOIS, Charles: "Phénoménologie, Cybernétique et Prospective". Ass. Int. Cybernét., Namur, Belgium, 1976
- FRANÇOIS, Charles: "La dinámica de sistemas evaluada en el marco de la Teoría General de Sistemas". Bol. Sociedad Argentina de Investigación Operativa, nr. 34, Buenos Aires, 1977
- FRANÇOIS, Charles: "Introducción a la Prospectiva". Pleamar, Buenos Aires, 1978
- FRANÇOIS, Charles: "Conceptual isomorphism: the crux of any general system methodology of modeling". – Proc. 26th Ann. Meet. SGSR, 1982, p. 1103-1107
- FRANÇOIS, Charles: "Control of and Control for". Cybernetica, 26 (3) 1983
- FRANÇOIS, Charles: "Patología de los Sistemas Complejos". GESI-AATGSC, Buenos Aires, 1984
- FRANÇOIS, Charles: "Consequences of Gödel's theorem for the metasystem paradigm", in J. van Gigh (ed): Decision making about decision making". Abacus Press, Cambridge, Mass., 1987
- FRANÇOIS, Charles: "Autogenesis, Autopoiesis and Emergence: a difficult interconnexion". 33rd. Meeting of the ISSS, Edinburgh, 1989
- FRANÇOIS, Charles: "Unperceived correlativity in man-made disasters". 12th Congress of the International Cybernetics Association, Namur, Belgium, 1989
- FRANÇOIS, Charles: "Problemología: Una metodología para la definición y el planteamiento de los problemas sistémicos". Sistémica, 2 (1), Instit. Andino de Sist., Lima, Peru, 1991
- FRANÇOIS, Charles: "Remarques à propos du modèle de système autonome de F. Bonsack". Institut de la Méthode, Bienne, 1992
- FRANÇOIS, Charles: "Inter, Multi, or Transdisciplinarity". in B. Banathy & R. Rodriguez Delgado (eds): "Int. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- FRANÇOIS, Charles: "An Integrative View of Meta-System Transition". World Futures, Vol.45, 1995
- FRANÇOIS, Charles: "Prospectiva de los Sistemas Complejos", Biblioteca Nacional, Buenos Aires, 1996
- FRANÇOIS, Charles: "A Systemic View of Systemic-Cybernetic Language" – Cybernetica, Vol XL, Nr.4, 1997
- FRANÇOIS, Charles: "The wishful anticipator" – CASYS J. 2, Inst. de Math., Univ. de Liège, 1998
- FRANÇOIS, Charles: "Human system inquiry about sustainable development" – 42nd Conf. of the ISSS, Georgia Technology Institute., Atlanta, 1998
- FRANÇOIS, Charles: "La Systémique, Un Méta-Language connectif" – Rev. Internat. de Syst., Vol.12, Nr.4/5, Gauthier Villars, Paris, 1998
- FRANÇOIS, Charles: "El Camino de la Globalización: Una Vision Sistémica" – I.S.S.S.- Sistémica 99 Conference, Instituto Andino de Sistemas, Lima, Perú, Junio 1999.
- FRANÇOIS, Charles: "Systemics and Cybernetics in a Historical Perspective" – SRBVS, 16 (3), 1999
- FRANÇOIS, Charles: "Determinism and chaos: A Time Perspective" – CASYS International Journ. of Computing Anticipatory Systems, Centre for Hyperincursion and Anticipation in Ordered Systems (CHAOS). Vol. 5, 2000
- FRANÇOIS, Charles: "An exploration of the historical meaning of systemics in western thought" – Systems J., Wroclaw, Poland, 2000
- FRANÇOIS, Charles: "Problemología: una metodología de indagación de los problemas complejos" – Conferencia Sistémica 2K, Lima, Perú, 2001 (A tutorial in spanish)
- FRANÇOIS, Charles: "Del ayer al mañana: hacia un mejor entendimiento y manejo de las situaciones complejas" (A tutorial). Conf. CONEIS, Univ. Nacional de Ingeniería, Lima, Perú, Agosto, 2001
- FRANÇOIS, Charles: "Diagnóstico de la persona humana: los dictados de nuestro sistema nervioso" – Conferencia Sistémica 2K, Lima, Perú, 2001
- FRANÇOIS, Charles: "History and Philosophy of Systems Sciences" – (in UNESCO: Encyclopedia of Life Support Systems, sect. 46.1.1.1. EOLLS Publ.Co., Aldates, Oxford, UK, 2003
- FRANÇOIS, Charles: "Prospectiva: estudio del futuro, conceptos y modelos" – Instituto Andino de Sistemas, Lima, Perú, 2003
- FRANÇOIS, Charles: "Transdisciplinary Unified Theory" – 2003- (paper to be submitted)
- FRANK, Helmar: "Kybernetik und Philosophie". Duncker und Humblot, Berlin, 1969
- FRANK, Helmar: "Kybernetische Grundlagen der Pädagogik". Aegis, Baden Baden, 1969
- FRANK, Manfred: "Selbstbewusstsein und Selbsterkenntnis" – Philipp Reclam Jun., Stuttgart, 1991
- FRANK, M. & WAKS, S.: "Engineering systems thinking: a multifunctional definition". SPAR, 14(3) 2001
- FRANKLIN, S.: "Artificial minds" – MIT Press, Cambridge, MA, 1995
- FRANKLIN, Stan: "Artificial Minds". MIT Press, Cambridge, Massachusetts, 1995
- FRANKS, N.R.: "Army Ants: A Collective Intelligence". Amer. Sc., Vol.77, 2, p.139-45, 1989
- FRANTZ, T.G. & MILLER, C.: "An idealized design approach" – World Futures, 36 (2-4) p. 83-106, 1993
- FREEMAN, Walter J.: "Mass action in the nervous system". Academic Press, New York, 1975
- FREEMAN, W.J.: "Societies of brains: a study in the neurosciences of love and hate" – L. Erlbaum, Hillsdale, NJ., 1995
- FREEMAN, W. & BURNS, J.: "Societies of brains" – J. of Consciousness Studies, 3(2), 1996
- FREGE, Gottlob: "Grundgesetze der Arithmetik, Vol. 1-2. Jena Verlag Hermann Pohle, 1893, 1903. In English: "The basic laws of arithmetic" (Transl. Montgomery Furth) Univ. of California Press, 1967
- FREIGASSNER, R. et al.: "Systems approach to validation of simulation models" – Proc. 15th Cyb. & Syst. Meeting, Austrian Society for Cyb. Studies, Vienna, 2000
- FRIEDMAN, George: "Constraint theory: An overview". Intern. J. of Syst. Science, 7 (10), 1976
- FRISCHKNECHT, F. & VAN GIGCH, J.P.: "The information system processing triad: Common core of human disciplines". Behav. Science, 34 (4) 1989
- FRITZ, Walter: "The intelligent system". SIGART Newsletter, 90, 1984
- FRITZ, Walter et al.: "The autonomous intelligent system". Robot. & Autom. Syst., 5, 1989
- FRITZ, Walter: "The origins of generalized mindscapes". GESI, Buenos Aires, 1995
- FRITZ, Walter: "Intelligent Systems" – <http://www.ance.net.ar>
- FROOD, Arran: "The weakest link" – N.Sc. nr. 2304, Aug.18, 2001
- FU, K.S. (ed.): "Learning systems". Asme Publ., 1973
- FUCHS, Christian: "Social information and self-organization" – Proc. 16th Meeting on Cybernetics and Systems, Vienna, 2002
- FUCHS, Christian: "Structuration theory and self-organization" – SPAR, 16(2) 2003
- FUCHS, Christian et al.: "The dialectic of Bottom-up and Top-down emergence in social systems" – Sistémica (forthcoming)
- FUENMAYOR, A. & R.: "Researching-acting-reflecting on public health services in Venezuela: I and II, SPAR, 12(1), 1999
- FUENMAYOR, Ramses: "Systems thinking and critique: I. What is critique?" – Systems Practice 3(6), 1990
- FUENMAYOR, R. & LOPEZ GARAY, H.: "The scene for interpretive systemology" – Syst. Practice 4, 1991
- FUENMAYOR, Ramses: "The roots of Reductionism: A Counter Onto-epistemology for a System Approach" – Systems Practice, Vol.4, Nr.5, 1991a
- FUENMAYOR, Ramses: "Between systems thinking and systems practice" – Syst.Pract., 4(5), 1991
- FUENMAYOR, Ramses: "The self-referential structure of an everyday-living situation: a phenomenological ontology for interpretive systemology" – Syst. Practice 4, 1991b

- FUENMAYOR, Ramses: "Truth and openness; an epistemology for interpretive systemology"- Syst. Practice 4, 1991c
- FUENMAYOR, Ramses: "The historical meaning of present systems thinking"- SRBVS, 14(4), 1997
- FUENMAYOR, Ramses: "A brief crack of light? (On Checkland's soft systems methodology)"- SPAR, 13(6), 2000
- FUENMAYOR, Ramses: "The oblivion of Churchmann's plea for a systems approach to world problems (3 parts)- SPAR, 14 (3) 2001
- FUKUNAGA, K.: "Introduction to Statistical Pattern Recognition", 2 ed. -Academic Press, New York, 1990
- FULLER, Buckminster: "Synergetics" - McMillan, New York, 1975
- FULLER, Buckminster: "Synergetics 2"- McMillan, New York, 1979
- FULLER, Buckminster: "Everything I know" - Buckminster Fuller Institute, Sebastopol, CA., 1997
- FULLER, R.& PUTNAM, P.: "On the Origin of Order in Behavior". SGSR Yearbook 9, 1967
- FULLER, Steve: "Death to all magic bullets". New Scientist, nr. 1976, 1995
- FUNG, Yu-Lan: "A History of Chinese Philosophy" - Allen & Unwin, London, 1952 - In French: "Précis d'Histoire de la Philosophie Chinoise" - Payot, Paris, 1952
- GADAMER, Hans Georg : "Philosophical Hermeneutics" - University of Chicago Press, Berkeley, 1976
- GADAMER, Hans Georg: "L'art de comprendre; Ecrits I. Herméneutique et tradition philosophique, II. Herméneutique et champs de l'expérience humaine"- Aubier, Paris, 1982, 1991
- GADAMER, Hans Georg: "Gesammelte Werke" (10 vol.)- J.C.B. Mohr (P. Siebeck), Tübingen, 1985-1995
- GADAMER, Hans Georg: "Langage et Vérité" (trad.J.C. Gens)- Gallimard, Paris, 1995
- GADAMER, Hans Georg: "La philosophie herméneutique" (transl. J. Grondin) Presses Univ. de France, Paris, 1996
- GADAMER, Hans Georg: "Vérité et Méthode: Les grandes lignes d'une herméneutique philosophique"- Ed. du Seuil, Paris, 1996
- GAINES, Brian R.: "The role of randomness in cybernetic systems". Proc. of Cyb. Soc., London, 1974
- GAINES, B.R. & KOHOUT, L.J.: "The Logic of Automata". Intern. J. Gen Systems, 2 (4) 1976
- GAINES, Brian R.: "System identification, Approximation and Complexity". Intern. J. Gen. Syst., 3 (3) 1977
- GAINES, Brian R.: "Methodology in the large: modeling all there is", in Klir, G.(ed.): "Facets of System Science". Plenum Press, New York, 1991
- GAINES, B.R. & SHAW, M.L.G.: "Hierarchies of distinction as generators of systems theories"- Gen. Syst. Yearbook, XXIX, 1985-86, p. 33-40
- GALL, John: "Systemantics: how systems work...and specially how they fail"- Pocket Books, New York, 1978
- GALLEGHER, J. & KRAUT, R. & EGIDO, C.(eds.): "Intellectual teamwork: social and technical foundations of cooperative work"- L. Erlbaum, Hillsdale, NH, 1990
- GALLEGHER, S. & SHEAR, J.(eds.): "Models of the self" - Imprint Academic, Thorverton, UK, 1999
- GALLOWAY, John: "Nature's second favorite structure". New Scientist, Nr.1606, 31 March 1988
- GAMMAITONI, L. et al.: "Stochastic resonance" - Rev. Mod. Phys., 70, 1998
- GAO, Fei et al.: "Critical systems thinking as a way to manage knowledge"- SRBVS, 20(1), 2003
- GAO, S.J. & CHARLWOOD, F.J.: "Self-Organization, Systems, Evolution and ancient Chinese Philosophy", in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- GARAJEDAGHI, J.: "Towards a systems theory of organization". Intersystems, San Francisco, 1985
- GARDNER, Howard: "Frames of Mind". Basic Books, New York, 1985
- GARDNER, H.: "The mind's new science"- Basic Books, New York, 1985
- GARDNER, Martin: "On the meaning of randomness and some ways of achieving it". Sc. American, July 1968
- GARDNER, Martin: "On cellular automata: Self-reproduction". Sc. American, 224 (2), 1972
- GARDNER, R.A. et al.(eds.): "Teaching sign language to chimpanzees" - State Univ. of New York Press, Albany, 1989
- GARNER, B.J.: "Cybernetic reasoning systems". Scima, 16 (3), New Delhi, 1987
- GARNIER-MALET, J.P.: "Geometrical model of anticipatory embedded systems"- CASYS J., 3, Liège, Belgium, 1999
- GARRATT, B.: "The learning organization" - Harper Collins, London, 1994
- GARVER, W. & MOSS, F.: "Electronic Fireflies". Sc. American, 269 (6) 1993
- GARVIN, P.: "Cognition: a multiple view". Spartan Books, Washington, 1972
- GASPARSKI, Wojciech W.: "Statement". Intern. J. Gen. Systems, 3 (1) 1976
- GASPARSKI, Wojciech W.: "Methodology of Design" in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- GASPARSKI, Wojciech W et al.: "Praxiologies and the philosophy of economics"- Trans. Rutgers Univ., N.J., 1993
- GASPARSKI, Wojciech W., GREGORY, Sidney A., FOUQUÉ, Richard, STRZALECKI, Andrzej: "Contemporary History of Design Science" in COLLEN, A. and GASPARSKI, W. (Eds): "Design and Systems" - Transaction Publ., New Brunswick (U.S.A.) & London, 1995
- GASPARSKI, Wojciech W.: "Ethical problems of information systems"- Proceed. 14th Meet. of Cybernetics and Systems, Vienna, 1998
- GATES, Jeff: "The Ownership Solution: Toward a Shared Capitalism for the 21st Century" - Addison Wesley, Reading, Mass, 1998
- GAUCH, Hugh C. Jr.: "Prediction, parsimony and noise". Amer. Scientist, 81 (5), 1993
- GAZZANIGA, Michael: "Nature's mind". Basic Books, New York, 1992
- GAZZANIGA, M.S.: "Nature's mind: the biological roots of thinking, emotions, sexuality, language and intelligence" - Basic Books, New York, 1992
- GAZZANIGA, M.S.(ed.): "The cognitive neurosciences" - MIT Press, Cambridge, MA., 1995
- GAZZANIGA, M.S. et al.: "Cognitive neuroscience: the biology of the mind" - W.W. Norton, New York, 1998
- GAZZANIGA, Michael: "The social brain". Basic Books, New York, 1985 (French translation used)
- GEERAERTS, Gustaaf: "War, Hypercomplexity and computer simulation". Syst Research, 11 (4) 1994
- GEHRING, Walter G.: "De la Mouche à l'Homme, un même Supergène pour l' Oeil". La Recherche, nr.280, 1995
- GELDENHUYS, A.E. et al.: "Knowledge representation and relation nets"- Kluwer, Dordrecht, 1999
- GELDER van der, T.: "What is the "D" in "PDP": a survey of the concept of distribution; in RAMSAY, W et al. (Eds): "Philosophy and Connectionist Theory" - Erlbaum, Hillsdale, N.J., 1991
- GELL-MAN, Murray: "The quark and the jaguar; Adventures in the simple and the complex".- Little Brown, London, 1994
- GELL-MAN, Murray: "What is Complexity" - Complexity, Vol.1, Nr.1, 1995
- GENESERETH, M. & NILSSON, N.J.: "Logical foundations of artificial intelligence" - Morgan Kaufmann Publ., 1987
- GENTER, D. & STEVENS, A. (eds.): "Mental models"- Erlbaum, Hillsdale, N.J., 1983
- GEORGE, Frank: "Logic and behavior". Science News, 45, Penguin, Harmondsworth, 1957
- GEORGE, Frank: "The brain as a computer". Pergamon, New York, 1961
- GEORGE, Frank: "Models of Thinking". Allen & Unwin, London, 1970
- GEORGE, Frank: "The foundations of cybernetics". Gordon and Breach, London, 1977
- GEORGE, Frank: "Philosophical foundations of cybernetics". Abacus, Tunbridge Wells, Engl, 1979
- GEORGE, Frank: "The science of philosophy". Gordon & Breach, New York, 1981
- GEORGE, Frank & JOHNSON, Les (eds): "Purposive behavior and teleological explanations". Gordon & Breach, New York, 1985
- GEORGE, Frank: "Philosophy, Semantics and Cybernetics". Kybernetes, 20 (6), 1991
- GEORGESCU-ROEGEN, Nicolas: "The entropy law and the economic process". Basic Books, New York, 1971
- GEORGESCU-ROEGEN, Nicholas: "Demain la décroissance. Entropie, écologie, économie" - Favre, Lausanne, 1979
- GEORGESCU-ROEGEN, Nicolas: "Energy analysis and technology assessment", in Schieve, W. & Allen, P. (eds): "Self-organization and dissipative structures". Univ. of Texas Press, Austin, 1982
- GEORGESCU-ROEGEN, Nicholas: "La décroissance" (a collection of his papers, edited by Grinevald, J. & Rens, I.) - Sang de la terre, Paris, 1995
- GEORGIU, Ion: "The ontological status of critique"- SPAR, 4(4), 2001
- GERARD, Ralph G.: "A biologist's view of society". SGSR Yearbook, 1, 1956
- GERARD, Ralph G.: "Units and concepts in biology". Science, 125, 1957
- GERARD, Ralph W.: "Entitation, animorgs and other systems", in Mesarovic, M. (ed): "Views on G.S. theory". Krieger Huntington, New York, 1974

- GERD, Brand: "Welt, Ich und Zeit: Nach unveröffentlichten Manuskripten E. Husserl's. Nijhoff, Den Haag, 1955
- GERGELY, T.: "On the unity between cybernetics and General Systems Theory". *Kybernetes*, 8 (1), 1979
- GERGEN, K.: "Social construction and the educational process" - (in: Steffe-Gale (eds.): *Constructivism in education*. - Erlbaum, Hillsdale, N.J., 1995)
- GERMANA, Joseph: "Emergent properties: a fundamental postulate of classical systems theory" - *SRBVS*, 18(6) 2001
- GERNERT, Dieter: "The formation of hierarchical structures as a key to self-organization", in G. Dale-noort (ed): "The paradigm of self-organization". Gordon & Breach, New York, 1989
- GERNERT, Dieter: "What can we learn from internal observers?" in Atmanspacher, H. & Dalenoort, G.(eds): "Inside versus outside". Springer, Berlin-Heidelberg, 1994
- GERNERT, Dieter: "Pragmatic information as a unifying concept" - In KORNWACHS, K. & JACOBY, K. (eds.): *Information: New questions to a multidisciplinary concept*- Akademie Verlag, Berlin, 1996
- GERNERT, Dieter: "Graph grammar as an analytical tool in physics and biology" - *Biosystems*, 43, 1997
- GERNERT, David: "On navigating in information space" - *CASYS J.*, 7, Inst. de Math., Univ. de Liège, Belgium, 2000
- GERNERT, Dieter: "Signs, models and interpretation: modern aspects of semiotics in Biology" - *CASYS*, 5, Univ. de Liège, Belgium, 2000
- GEYER, F. & van der ZOUWEN, J.(eds): "Socio-cybernetics". Vol.1 (4th. WOCOS Congress), M. Nijhoff, Leiden, 1978
- GEYER, F. & van der ZOUWEN, J.(eds): "Socio-cybernetic paradoxes: observation, evolution and control of self-steering systems". Sage Publ., London, 1986
- GEYER, Felix: "Political alienation and environmental complexity reduction". *Kybernetes*, 19 (4) 1990
- GEYER, Felix (ed): "The cybernetics of Complex Systems: Self-Organization, Evolution, Social Change". Intersystems, Salinas, CA, 1991
- GEYER, Felix: "Modern form of alienation in high-complexity environments". *Kybernetes*, 20 (2) 1991
- GEYER, Felix: "Alienation in community and society; effects of increasing environmental complexity". *Kybernetes*, 21 (2) 1992
- GEYER, Felix: "Alienation, Participation and Increasing Societal Complexity". *Kybernetes*, 23 (2), 1994
- GEYER, Felix: "The Challenge of Sociocybernetics". *Kybernetes*, 24 (4), 1995
- GHARAJEDAGHI, J. & ACKOFF, R.L.: "Toward systems education of systems scientists". *Syst. Research*, 2 (1), 1985
- GHISELIN, B. (ed.): "The creative process: a symposium" - Bantam, New York, 1952
- GIARINI, O. & STAHEL, W.: "Les limites du certain" - Presses Polytechniques et Universitaires Romandes, Lausanne, 1990
- GIBBONS, M. et al.: "The new production of knowledge: the dynamics of science and research in contemporary societies" - Sage, London, 1994
- GIBSON, J.E.: "Non linear automatic control". McGraw Hill, New York, 1963
- GIBSON, J.J.: "The senses considered as a perceptual system". Houghton Mifflin, Boston, 1966
- GIBSON, James J.: "The ecological approach to visual perception". Lea, Hillsdale, N.J., 1986
- GIDDENS, A.: "Central problems in social theory. Action structure and contradiction in social analysis" - Macmillan, London, 1979
- GIDDENS, A.: "The constitution of society" - Polity Press, Cambridge, U.K., 1984
- GIDDENS, A.: "Social theory and modern sociology" - Stanford Univ. Press, Stanford, CA, 1987
- GIDDENS, A.: "The consequences of modernity" - Stanford Univ. Press, Stanford, CA., 1990
- GIDDENS, A.: "New rules of sociological method" - Polity Press, Oxford, 1993
- GIDDENS, A.: "Politics, sociology, and social theory" - Stanford Univ. Press, Stanford, CA., 1995
- GIGCH, John: "Applied general systems theory". 2 ed. Harper & Row, New York, 1978
- GIGCH, John: A methodological comparison of the Science, System and metasystem paradigms" *Intern. J. of Man-Machine Studies*, 11 (5), 1979
- GIGCH, John van: "Una comparación metodológica de los paradigmas científico, sistémico y meta-sistémico" - Cuadernos GESI, (3), Buenos Aires, 1980, p. 17-40
- GIGCH, J.P. & KRAMER, N.J.T.: "A taxonomy of Systems Sciences". *Inter. J. of Man Machine Studies*, 14 (2) 1981
- GIGCH, John van: "Truth and the systems approach". 1982
- GIGCH, John (ed): "Decision making about decision making: metamodels and metasystems". Abacus, Cambridge, 1986
- GIGCH, John: "Applying the Metasystem Paradigm to improve our knowledge about knowledge", in de Zeeuw, G. (ed): "Knowledge (dis)appearance". Systeem Groep Nederland, Delft Univ. Press, 1986b
- GIGCH, John: "Levels of logic and of abstraction and the metasystem paradigm". *Rev. Intern. de Systématique*, 1 (3) 1987
- GIGCH, John van: "Design of the modern inquiring system (a series of papers)" - *Syst. Research*, 5, 10, 11, 14, 1988-1997
- GIGCH, John: "Designing the order inquiring system - II. The Contemporary Computer". *Syst. Research*, 5 (3) 1988
- GIGCH, John: "Systems Science, the discipline of epistemological domains". *Behav. Science*, 35 (2) 1990
- GIGCH, John: "The importance of metaethics". 12th World Congress of Sociology, Univ. Complutense, Madrid, 1990
- GIGCH, John van: "System design modeling and metamodeling" - Plenum Publ., New York, 1991
- GIGCH, John: "The Formulation of strategic management policies for the discipline of conservation". Univ. of Göteborg, Sweden, 1992
- GIGCH, John van: "Metamodeling: the epistemology of systems science" - *Syst. Pract.*, 6(3), 1993
- GIGCH, John: "Paradigms", in B. Banathy and R. Rodríguez Delgado (eds): "Intern. Syst. Science Handbook". Systemic Publications, Madrid, 1993
- GIGCH, John van: "Beyond Dispute", A Review of S. BEER's book - *Systems Research*, V.13 (1), 1996
- GIGCH, John van: "The viability of system science as a scientific discipline" - *Proceed. 42nd ISSS Conf.*, Atlanta, 1998
- GIGCH, John van: "Deconstructing the Problem of Comparing the Conflicting Imperatives of Technology and Sustainability" - *SRBVS*, Vol.16, (5) 1999
- GIGCH, John van: "An introduction to Epistemology" by Charles Landesman - *C&HK*, 6(3), 1999
- GIGCH, John van: "Metadecisions: problem solving through metamodeling" - Sebastopol, CA, 2001
- GIGCH, John van: "Comparing the epistemologies of scientific disciplines in two distinct domains, I. The epistemology and knowledge characteristics of the physical sciences". *SRBVS* 19(3) 2002; II. The epistemology and knowledge characteristics of the "new" social sciences" - *SRBVS* 19(6) 2002
- GIGCH, John van: "Metadecisions; rehabilitating epistemology" - Kluwer/Plenum, London, New York, 2003
- GILBERT, N. & DORAN, J. (eds.): "Simulating societies: the computer simulations of social phenomena" - UCL Press, London, 1994
- GILBERT, N. & CONTE, R. (eds.): "Artificial societies: the computer simulation of social life" - UCL Press, London, 1995
- GILLES DE GENNES, Pierre: "La Percolation, un concept unificateur" - *La Recherche*, Nro. 72, nov. 1976
- GINI, Corrado: "Teorías de la Población" - Aguilar, Madrid, 1952 (orig. in Italian)
- GIORDAN, André: "L'ère de la physionique". *La Recherche*, 284, 1996
- GIORGI, A.: "Psychology as a human science: a phenomenologically based approach" - Harper & Row, New York, 1970
- GLADWELL, Malcolm: "The Tipping Point" - Little, Brown, London, 2000
- GLANDSDORFF, P. & PRIGOGINE, I.: "Structure, Stabilité et Fluctuations". Masson, Paris, 1971, or "Structure, Stability and Fluctuations". Wiley, New York, 1971
- GLANTZ, Michael H.: "The Dying Aral Sea" - Work in Progress, Bulletin of the United Nations University, Tokyo, 1998
- GLANVILLE, Ranulph: "Consciousness, and so on ..." - *Proceed. 4th EMCSR*, Hemisphere Publ., Washington, DC, 1978
- GLANVILLE, Ranulph: "Leaving space for design" - a research paper, 1978a
- GLANVILLE, Ranulph: "Beyond the boundaries" - in ERICSON, R. (Ed.): "Improving the Human Condition": *Quality and Stability in Social Systems* - Springer, London, 1979
- GLANVILLE, Ranulph: "The form of Cybernetics: Whitening the Black Box" - *Proc. of the Soc. for General Systems Research Meeting*, Louisville, KY, 1979
- GLANVILLE, S. & VARELA, F.: "Your inside is out and your outside is in" - In Lasker, G. (ed.) *Applied systems and cybernetics*, VII, Pergamon, 1980
- GLANVILLE, Ranulph: "Inside every white box there are two black boxes trying to get out" - *Behav.-Science*, 12(1) 1982
- GLANVILLE, Ranulph: "Objekte" - Merve, Berlin, 1988
- GLANVILLE, R. & ZEEUW, G. de (eds.): "Problems of impossible worlds" - *Systemica* 7(1/6), 1988
- GLANVILLE, Ranulph & de ZEEUW, Gerard (eds): "Mutual uses of Cybernetics and Sciences" (2 vol.). Thesis, Amsterdam, 1991

- GLANVILLE, Ranulph: "The second disorder: the Amsterdam School". *Cybernetics & Systems Research* 92, World Scientific, Singapore, 1992
- GLANVILLE, Ranulph: "On becoming Gordon's student". *Syst. Research*, 10 (3), 1993
- GLANVILLE, R. & ZEEUW, G. de (eds.): "Problems of support, survival and culture". *Systemica*, 9, 1993
- GLANVILLE, Ranulph: "Variety in design". *Syst. Research*, 11 (3), 1994
- GLANVILLE, Ranulph: "Cybernetics musings" (Rambling and stimulating chronicles in C&HK, 2(4) 1994
- GLANVILLE, R. & ZEEUW, G. de (eds.): "Problems of values and (in) variants".- *Proceedings, THESIS Publ.*, 1995
- GLANVILLE, Ranulph: "Heinz von Foerster: Festschrift". *Syst. Research* 13 (3), 1996 (Contains a wealth of insights by numerous prominent systemists about this great founding father's work)
- GLANVILLE, Ranulph: "Robin McKinnon-Wood and Gordon Pask: a lifelong conversation"- *C&HK*, 3(4) 1996
- GLANVILLE, Ranulph: "A (cybernetic) musing: control 1" - *C&HK*, 4(1), 1997
- GLANVILLE, Ranulph: "A (cybernetic) musing: variety and creativity"- *C&HK*, 5 (2-3) 1997
- GLANVILLE, Ranulph: "Communication: conversation 1" - *C&HK*, 4(1), 1997
- GLANVILLE, Ranulph: "The gestation of 2nd order cybernetics, 1968-1975: a personal account"- *C&HK*, 5(2), 1998
- GLANVILLE, S., SENGUPTA, S. & FOREY, G.: "Language and science in the language of science"- *C&HK*, 5(4), 1998
- GLANVILLE, R. & ZEEUW, G. de (eds.): "Problems of excavating cybernetics and systems"- *Systemica*, 11, 1998
- GLANVILLE, Ranulph: "Varieties of variety: a cybernetic musing" - *C&HK*, 5(1), 1998a
- GLANVILLE, Ranulph: "Architecture and the embodiment of knowledge"- 1999
- GLANVILLE, R. & ZEEUW, G. de (eds.): "Problems of observation and action"- *Systemica*, 12 (1/6) 1999
- GLANVILLE, Ranulph: "Constructing my cybernetic world"- *C&HK*, 8(1-2) 2001
- GLANVILLE, Ranulph: "Cybernetics and human knowing"- *C&HK*, 9(1)2002
- GLANVILLE, Ranulph: "Francisco Varela (1946-2001): a working memory"- *C&HK* 9(2) 2002
- GLASERSFELD, E. von: "Cybernetics and Cognitive Development". *ASC Cyb. Forum*, 8 (3/4) 1976
- GLASERSFELD, Ernest von: "Wissen, Sprache und Wirklichkeit"- *Vieweg, Braunschweig*, 1987
- GLASERSFELD, Ernest von: "Notes sur une théorie de la connaissance pour organismes auto-régulateurs"- *Instituto Piaget, Lisboa*, 1987
- GLASERSFELD, E. von: "Wissen, Sprache und Wirklichkeit". *Vieweg, Wiesbaden*, 1987
- GLASERSFELD, E. von: "Introduction à un constructivisme radical", in P. Watzlawick (ed.): "L'invention de la réalité: contribution au constructivisme (1981-1985)". *Le Seuil, Paris*, 1988 (Original in German)
- GLASERSFELD, E. von: "The construction of knowledge". *Intersystems Publ., Seaside, CA.*, 1988
- GLASERSFELD, Ernest von: "Linguaggio e comunicazione nel costruttivismo radicale" - *CLUP, Milano*, 1989
- GLASERSFELD, E. von: "Konstruktion der Wirklichkeit und des Begriffs der Objectivität", in Watzlawick, P. (ed): "Einführung in den Konstruktivismus". *Piper, München*, 1991
- GLASERSFELD, Ernest von(ed.): "Radical constructivism in mathematics education" - *Kluwer, Dordrecht*, 1992
- GLASERSFELD, Ernest von: "Why I consider myself a cybernetician"- *C&HK*, 1(1), 1992
- GLASERSFELD, Ernest von: "Radical Constructivism. A way of knowing and learning" - *Falmer Press, London*, 1995
- GLASERSFELD, Ernest von: "Radical Constructivism: A Way of Knowing and Learning" *The Falmer Press, London*, 1995
- GLASERSFELD, Ernest von: "Cybernetics and the Art of Living". *Cyb. & Systems*, 27 (6), 1996
- GLASERSFELD, Ernest von: "Cybernetics and the Art of Living" - *C&S*, Vol.27, 6, 1996 (His address to the 13th European Meeting on Cybernetics & Systems Research, Vienna, April 1996)
- GLASERSFELD, Ernest von: "Farewell to objectivity".- *Syst. Res.*, 13, (2-3), 1996
- GLASERSFELD, Ernest von: "A cybernetician before cybernetics (von Foerster)" - *SRBVS*, 14(2), 1997
- GLASERSFELD, Ernest von: "Wege des Wissens: Erkundungen durch unser Denken"- *Carl Auer, Heidelberg*, 1997
- GLASERSFELD, Ernest von: "How do we mean? A constructivist sketch of semantics"- *C&HK*, 6 (1), 1999
- GLASERSFELD, Ernest von: "Reflections on cybernetics"- *C&HK* 7(1)2000
- GLEICK, James: "Chaos". *Cardinal, Penguin Books, Harmondsworth, Middlesex, or Viking Penguin, New York*, 1987
- GLENDINNING, Paul: "Stability, instability and chaos" - *Cambridge University Press, Edinburgh*, 1994
- GLOSTER, Michael: "Approaching action research from a socioecological perspective"- *SPAR* 13(5) 2000
- GLUCK, M. & RUMELHART, D.: "Neuroscience and connectionist theory" - *L. Erlbaum, Hillsdale, N.J.*, 1990
- GLUSHKOV, Viktor M.: "Introduction to Cybernetics". *Academic Press, New York*, 1966
- GOERNER, Sally: "Chaos and the evolving ecological universe" - *Gordon & Breach, Langhorne, PA*, 1994
- GOERNER, Sally: "After the clockwork universe" - *Floris Books, Edinburgh, Scotland*, 1999
- GOERNER, Sally: "Integral science: rethinking civilization using the learning universe lens"- *SRBVS*, 20(4) 2003
- GOERTZEL, Ben: "The structure of the intelligence: a new mathematical model of mind" - *Springer Verlag, New York*, 1993a
- GOERTZEL, Ben: "The evolving mind" - *Gordon and Breach, Amsterdam*, 1993 b
- GOERTZEL, Ben: "Chaotic logic: language, thought and reality from the perspective of complex systems science"- *Plenum Press, New York*, 1994
- GOERTZEL, Ben: "From complexity to creativity, explorations in evolutionary, autopoietic and cognitive dynamics"- *Plenum Press, New York*, 1997
- GOERTZEL, Ben : "Wild computing: steps toward a philosophy of internet intelligence" - <http://goertzel.org/ben/wild>, 1999
- GOGUEN, Joseph A.: "L-Fuzzy sets". *J. Math. Anal. & Appl.*, 18, 1967
- GOGUEN, Joseph A.: "Objects". *Intern. J. Gen. Systems*, 1 (4) 1974
- GOGUEN, J.A. & VARELA, F.A.: "Systems and Distinctions: Duality and complementary". *Intern. J. Gen. Systems*, 5 (1) 1979
- GOGUEN FRANTZ, Tad: "Family Stories as Mechanisms for Evolutionary Guidance". *Syst. Research*, 8 (2) 1991
- GOLDBERG, D.E.: "Genetic Algorithms in Search, Optimization and Machine Learning" - *Addison Wesley, Reading*, 1989
- GOLDENFELD, N. & KADANOFF, L.P.: "Simple Lessons from Complexity"- *Science*, Vol.284, Nr.5411, p. 87-89, April, 2, 1999
- GOLDSCHMIDT, Gabriela: "Serial sketching: Visual problem solving in designing". *Cyb. & Systems*, 23 (2) 1992
- GOLDSMITH, E.: "Thermodynamics or Ecodynamics?" *The Ecologist.*, 11 (4), 1981, p. 178-195
- GOLEMAN, D.: "Emotional intelligence: why it can matter more than I.Q." - *Bloomsbury Publ., London*, 1995
- GOLLEY, F.B.: "A history of the ecosystem concept in ecology" - *Yale Univ. Press, New Haven*, 1993
- GOMEZ, P.: "Frühwarnung in der Unternehmung" - *Haupt, Bern*, 1983
- GOMEZ, P. & PROBST, C.: "Vernetztes Denken in Management: eine Methodik des ganzheitlichen Problemlösens"- *Schweizerische Volksbank, die Orientierung*, nro.89, Bern, 1987
- GOMEZ, P. & PROBST, G.: "Organizational closure in management". *Cyb. & Systems*, 20 (4) 1989
- GOMOWSKI, J. & MIRA, C.: "Dynamique chaotique". *Cepadues Editions, Toulouse*, 1980
- GOMOWSKI, J. & MIRA, C.: "Recurrences and discrete dynamic systems". *Springer, New York*, 1980
- GONDRAN, M. & LALEUF, J.C.: "Intelligence artificielle et systèmes experts". *Interfaces* n°64, AFCET, Paris, fev. 1988
- GONELLA, J.: *Communication IMEKO Conference. Rev. philosoph., Univ. Paris VI, mars 1976*
- GONSETH, Ferdinand: "Determinisme et libre arbitre". *Le Griffon, Lausanne*, 1944
- GONSETH, Ferdinand: "La géométrie et le problème de l'espace" 6 vol., *Le Griffon, Neuchatel*, 1945
- GONSETH, Ferdinand: "Logique Formelle et Logique Dialectique" - *Éditions Sociales, Paris*, 1947
- GONSETH, Ferdinand: "Connaître par la science"- *Dialectica*, 8(3)& 9(1/2), 1954-55 a,b
- GONSETH, Ferdinand: "Recherches méthodologiques"- *Dialectica* 9(1/2), 1955b
- GONSETH, Ferdinand: "L'ouverture à l'expérience et les a-priori".- *Dialectica*, 9(1/2), 1955 a
- GOODMAN, I.R. & NGUYEN, N.T.: "Uncertainty models for knowledge based systems". *North Holland, Amsterdam*, 1985
- GOODWIN, Brian: "Der Leopard der seine Flecken verliert: Evolution und Komplexität"- *Piper, München*, 1997
- GOODWIN, Brian: "All for one, One for all" - *N.Sc.*, June 13th, 1998
- GOONATILAKE, Susantha: "The evolution of information". *Pinter Publ., London*, 1991

- GOPPOLD, Andreas: "Time, anticipation and pattern processors" - CASYS J., 7, Inst. Math., Univ. de Liège, 2000
- GORDON, Deborah M.: "The development of organization in an ant colony". *Amer. Scientist*, 83 (1) 1995
- GORDON, T. & GREENSPAN, D.: "The management of chaotic systems" - *Technological forecasting and social change*, v. 47, 1994
- GORE, Al: "Earth in the balance" - Houghton Mifflin, New York, 1992
- GORELIK, G.: "Principal ideas of Bogdanov's tektology: the universal science of organization" - *General systems*, 20, 1975
- GORELIK, G.: "Essays from tektology" 2nd. Ed. - *Inter-systems*, Seaside, CA, 1984
- GOTTLIEB, G.: "Synthetizing nature-nurture: prenatal roots of instinctive behavior" - L. Erlbaum, Mahwah, N.J., 1997
- GOTTSCHALCH, W.: "Wahrnehmen, Verstehen, Helfen: Grundlagen psychosozialen Handelns" - R. Ainswager Verlag, Heidelberg, 1988
- GOUDSMIT, A.L.: "Organizational closure; the process of psychotherapy and the psychologist's fallacy", in Dalenoot, G.J. (ed): "The paradigm of self-organization". Gordon and Breach, New York, 1989
- GOUDZWAARD, B.: "Capitalism and progress: a diagnosis of western society" - Paternoster Press, Carlisle, 1997
- GOUJON, Philippe: "Analyses historiques et épistémologiques des relations entre entropie, néguentropie et information: Maxwell, Szilard, Brillouin" - *Cybernetica*, 39 (3) 1996
- GOUJON, Philippe: "Analyses historiques et épistémologiques des relations entre entropie, néguentropie et information: de Maxwell et Szilard à Brillouin". *Cybernetica* 39 (3), 1996
- GOULD, P. & WALLACE, R.: "Spatial structures and scientific paradoxes in the AIDS pandemic". *Geografiska Annaler*, 76B, 105, 1994
- GOULD, Peter: "La Géographie du SIDA". *La Recherche*, Nr.280, 1995
- GOULD, Stephen J.: "Hen's teeth and horse's toes". Norton & Co., New York, 1983
- GOULD, Stephen J.: "The meaning of punctuated equilibrium and its role in validating a hierarchical approach to macro-evolution". *Scientia*, 118 (I-VIII), Milano, 1983
- GOULD, Stephen J.: "Bully for Brontosaurus". W.W. Norton, New York, 1991
- GOULD, S.J. & ELDEREDGE, N.: "Punctuated equilibrium comes of age". *Nature*, 366, 1993
- GOURLEY, R.M.: "Systems and Transformation at the University of Natal" - *SRBVS*, Vol.16, Nr.2, 1999
- GOWDY, J.: "Coevolutionary economics: economy, society and the environment" - Kluwer, Boston, 1994
- GOYEAU, Pascal: "Autonomie du social et rôle de l'observateur" - *Rev. Intern. Systémique*, 11(5) 1997
- GRAHAM, I.: "Object-oriented methods" - Addison Wesley, Reading, MA, 1994
- GRAHAM-ROWE, Duncan: "Robots will learn like we do" - *New Sc.*, nr. 2354, Aug.3, 2002
- GRANGER, Gilles-Gaston: "La Mathématique Sociale du Marquis de Condorcet" - Presses Univ. de France, Paris, 1956
- GRANT, Ragnar: "The purposive brain" - MIT Press, Cambridge, MA., 1979
- GRANT, L. & EVANS, A.: "Principles of behavior analysis" - Harper Collins, New York, 1994
- GRAS, A.: "Sociologie des Macro-systèmes techniques". Presses Univ. de France, Paris, 1993
- GRAS, Alain: "Les Macro-Systèmes techniques" - Que Sais-je, Presses Univ. de France, 1997
- GRASSBERGER, Peter: "Chaos and diffusion in deterministic cellular automata". *Physica* 10D, 1984
- GRASSBERGER, Peter: "La percolation ou la géométrie de la contagion". *La Recherche*. nr. 232, mai 1991
- GRASSÉ, P.P.: "La reconstruction du nid et les coordinations inter-individuelles: la théorie de la stigmergie". *Insectes sociaux*, 6, 1959
- GRAUPE, D.: "Identification of systems". Krieger, New York, 1972
- GRAY, John: "I think, but who am I? : an interview" - Suhrkamp, Frankfurt a/M, 1994
- GRAY, W., DAHL, F.J. & RIZZO, N. (eds): "General Systems Theory and psychiatry". Little Brown, Boston, 1969
- GRAY, William & RIZZO, Nicholas (eds): "Unity through diversity: A Festschrift in honor of L. von Bertalanffy". 2 Vol., Braziller, New York, 1973
- GRAY, William: "General System precursor formation theory". Aristocrat, Cambridge, Mass., 1977
- GREEN, Elmer E. and Alyce: "Regulating our mind-body Processes". *Fields within fields*, nr. 10, 1973-74
- GREEN, E. & A.: "Behind biofeedback" - Delacorte, New York, 1977
- GREENE, Kenyon de: "Sociotechnical Systems". Prentice Hall, Englewood Cliffs, 1973
- GREENE, Kenyon de: "Limits to societal systems adaptability". *Behav. Science* 26 (2), 1981
- GREENE, Kenyon de: "The Kondratiev Phenomenon: a Systems Perspective". *Syst. Research* 5 (4) 1988
- GREENE, Kenyon de: "Micro-macro interrelations and the order parameter concept in the field theory of societal systems". *Syst. Research* 6 (4) 1989
- GREENE, Kenyon de: "Nonlinear management in technologically induced fields". *Syst. Research* 7 (3) 1990
- GREENE, Kenyon de: "Evolving System-Fields, versus Context-free, future perspectives: some thoughts on controllability". *Syst. Research*, 8 (2) 1991
- GREENE, Kenyon de: "Rigidity and fragility of large socio-technical systems". *Behav. Science*, 36, 1991b
- GREENE, Kenyon de: "Will there be a fifth KONDRATIEV cycle-structure?". *Syst. Research*, 10 (4) 1993
- GREENE, Kenyon de: "Can systems dynamics be theoretically improved and, if so, does it matter practically?". *Syst. Research*, 11 (3) 1994
- GREENE, Kenyon de: "The systems thinker as revolutionary". *Syst. Research*, 12 (2) 1995
- GRENFESTETTE, J.J. (Ed): "Proceedings of the 1st International Conference on Genetic Algorithms" - Morgan Kaufmann, San Mateo, CA, 1985
- GRENFESTETTE, J.J. (ed.): "Proceedings of the 2nd International Conference on Genetic Algorithms" - Morgan Kaufmann, San Mateo, CA, 1987 (See also SCHAFFER, J.D.)
- GREGORY, Amanda: "Against evaluation?" - *C&S*, 27(6)1996
- GREGORY, Dick: "Distinguishing G. Pask's cybernetics". *Syst. Research*, 10 (3) 1993
- GREGORY, R.L.: "Mind in science: a history of explanations in psychology and physics" - Weidenfeld and Nicholson, London, 1981 (and Penguin-Harmondsworth, 1984)
- GREGORY, S.A.(Ed.): "The Design Method" - Butterworth, London, 1966
- GREGORY, Wendy: "Discordant Pluralism: A New Strategy for Critical Systems Thinking?" *Syst. Practice*, 9 (6), 1996
- GREGORY, Wendy: "Transforming self and society: a 'critical appreciation model'" - *SPAR*, 13(4), 2000
- GREGORY, W. & MIDGLEY, G.: "System thinking for social responsibility" - *SRBVS*, 20(2) 2003
- GREIDER, William: "One world, ready or not" - Simon & Schuster, New York, 1997
- GREIG-SMITH, Peter: "The trees bite back". *New Scientist*, (1506) 1986
- GREIMAS, A.J. & COURTES, J.: "Semiotics and language: an Analytical Dictionary". - Indiana Univ. Press, Bloomington, 1982 (french original: *Sémiotique. Dictionnaire raisonné de la théorie des langages*), 1979)
- GRENIOWSKI, Henryk: "Cybernetics without mathematics". Pergamon Press, New York, 1960. (Original in Polish; French translation: "Cybernétique sans mathématiques". Gauthier Villars, Paris, 1965)
- GREUSSAY, Patrick: "L'ordinateur cellulaire". *La Recherche*, nr 204, nov.1988
- GRIBBIN, John: "Schrödinger's kittens and the search for reality" - Little, Brown and Co., Boston, 1995
- GRIFFITH, J.S.: "On the stability of brain-like structures". *SGSR Yearbook*, 10, 1965
- GRINKER, Roy (ed): "Toward a unified theory of human behavior". Basic Books, New York, 1956
- GROF, Stanislaw: "Realms of the Human Unconscious" - Dutton, New York, 1976
- GROF, Stanislaw: "Beyond the Brain" - State Univ. of New York Press, Albany, NY, 1985
- GRONDIN, Jean: "Hermeneutische Wahrheit? Zum Wahrheitsbegriff Hans Georg Gadamer's" 2nd ed.- Belz, Athenäum, Weinheim, 1994
- GRONDIN, Jean: "Sources of Hermeneutics" - SUNY Press, Albany, NY., 1995
- GRONDIN, Jean: "Introduction a Hans-Georg Gadamer" - Ed. du Cerf, Paris, 1999
- GROSS, Peter: "Die multioptionsgesellschaft" - Suhrkamp, Frankfurt a/M, 1968
- GROSSBERG, S.: "Nonlinear neural networks: principles, mechanisms and architectures" - *Neur. Netw.* 1, 1988
- GROSSBERG, Stephen: "The attentive brain". *Amer. Scientist*, 83 (5) 1995
- GROSSING, G.: "The universal principle of perception and its inadequacy", in G. Lasker: "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- GROSSMAN, Wendy: "Fear and grokking on the war crimes trail" - *N.Sc.*, nr. 2388, march 29, 2003
- GROSSMANN, W.D. & WATT, K.E.F.: "Viability and sustainability of civilizations, corporations, institutions and ecological systems". *Syst. Research*, 9 (1) 1992
- GRÜN, Ernesto: "Una visión sistémica y cibernética del derecho". Abeledo Perrot, Buenos Aires, 1995

- GRÜNBAUM, A.: "Philosophical problems of space and time" - Reidel, Boston, 1973
- GRUNDMANN, Matthias (Hg.): "Konstruktivistische Socializations - Forschung" - Suhrkamp, Frankfurt, 1999
- GU, J. & ZHU, Z.: "Knowing Wuli, sensing Shili, caring Renli: Methodology of the WSR approach" - SPAR, 3(1) 2000
- GU JIFA & ZHICHANG ZHU: "Knowing Wuli, sensing Shili, caring for Renli. Methodology of the WSR Approach" - 3(1) 2000
- GUASTELLO, S.J.: "Chaos, catastrophe and human affairs: applications of nonlinear dynamics to work organizations, and social evolution" - Lawrence Erlbaum Ass., Mahwah, NJ, 1995
- GUBA, Egon: "The Paradigm Dialog". Sage Publ., New York, 1990
- GUBERMAN, S. & ANDREWSKY, E.: "From language pathology to automatic language processing...and return", Cyb. & Hum. Knowing, 3 (4) 1996
- GUDDERI, Philip: "Autopoiesis, Semeiosis and co-coupling: a relational language for describing communication and adaptation" - C&HK, 7(2-3) 2000
- GÜNTHER, Gotthard: "Cybernetical ontology and trans-junctional operations", in Yovits and Jacobi (Eds.): "Self organizing systems". Spartan Books, Washington, 1962
- GULLAUME, Paul: "La Psychologie de la Forme". Flammarion, Paris, 1937
- GUMOWSKI, I. & MIRA, C.: "Recurrences and Discrete Dynamic Systems" - Lecture Notes on Mathematics, 809 - Springer, New York, 1980
- GUNDERSON, Norman O.: "Introduction to cybernetic systems". Lansford Public., San Jose, Ca., 1972
- GUOHUA, B. & LINDBERG, L.A.: "Dialectical approach to systems development" - SRBVS, 15(1) 1998
- GUPTA, A. & BELNAP, N.: "The revision theory of truth" - MIT Press, Cambridge, Mass., 1993
- GUPTA, M. & RAO, D.: "Neuro-control systems" - IEEE Press, New York, 1994
- GURA, Trisha: "Rhythm of life" - N.Sc., nr. 2302, Aug. 4th, 2001
- GUREL, O. & ROSSLER, O.E.: "Bifurcations theory and applications in scientific disciplines". New York Acad. of Sciences, New York, 1979
- GUTTINGER, G. & DANGELMAYR, G. (eds.): "The physics of structure formation" - Springer, Berlin, 1987
- HAACK, Susan: "How the critical common-sensist see things" - Histoire, épistémologie, Langage - 16/1, 1994
- HAAS, Michael: "Types of asymmetries in social and political systems". SGSR Yearbook 12, 1967
- HABERMAS, Jürgen: "Technik und Wissenschaft als Ideologie" - Suhrkamp, Frankfurt a/M, 1968
- HABERMAS, Jürgen: "Theory and practice" (J. Viertel, trans) - Heinemann, London, 1974 (orig. work publ. 1968)
- HABERMAS, Jürgen: "Knowledge and Human Interests" - Beacon, Boston, 1971
- HABERMAS, Jürgen: "Toward a rational society" (J. Shapiro, trans) - Beacon Press, Boston (orig. work publ. 1961) 1971 b
- HABERMAS, J. & LUHMANN, N.: "Theorie der Gesellschaft oder Sozialtechnologie: was leistet die Systemforschung" - Suhrkamp, Frankfurt a.M., 1971
- HABERMAS, Jürgen: "Legitimation Crisis" (T. McCarthy, trans) - Beacon Press, Boston, 1975 (orig. work publ. 1973)
- HABERMAS, Jürgen: "Communication and the evolution of society" - T. McCarthy, trans) - Beacon Press, Boston, 1979 (orig. work publ. 1976)
- HABERMAS, Jürgen: "Reason and the rationalization of society" - Beacon Press, Boston, 1984
- HABERMAS, Jürgen: "The philosophical discourse of modernity" (F.G. Lawrence, trans) - The MIT Press, Cambridge, 1987 (orig. work publ. 1985)
- HABERMAS, Jürgen: "The Theory of communicative action: vol.1: Reason and the rationalization of society" - Beacon Press, Boston, 1984 vol.2: "A critique of functionalist Reason" - Beacon Press, Boston, 1987
- HABERMAS, Jürgen: "The structural transformation of the public sphere" - Polity Press, Cambridge, 1989
- HABERMAS, Jürgen: "The theory of communicative action: vol. 2 Lifeworld and system" - Beacon Press, Boston, MA, 1989
- HABERMAS, Jürgen: "Moral consciousness and communicative action" - MIT Press, Cambridge, MA, 1990
- HABERMAS, Jürgen: "Between facts and norms" - MIT PRESS, Cambridge, MA, 1996
- HABERMAS, Jürgen: for a good bibliography, see BAUSCH, Kenneth, C. in SRBVS, 14, sept.-oct. 1997
- HAECKEL, E.: "Natürliche Schöpfungsgeschichte. Gemeinverständliche wissenschaftliche Vorträge über die Entwicklungslehre" - Reimer, Berlin, 1868
- HAHN, L.E.: "The philosophy of H.G. Gadamer" - Open Court, Chicago and La Salle, IL., 1997
- HAIRE, M. (ed): "Modern organization theory". Wiley, New York, 1959
- HAKEN, Hermann: "Cooperative Phenomena" - Springer, New York, 1973
- HAKEN, Hermann (ed): "Dynamics of synergetic systems". Springer, New York, 1980
- HAKEN, Hermann: "Advanced Synergetics". Springer, Heidelberg, 1983
- HAKEN, Hermann: "Synergetics; an introduction". Springer, Berlin, 1983
- HAKEN, Hermann: "Erfolgsgeheimnisse der Natur". Deutsche Verlags-Anstalt, Stuttgart, 1981 (Spanish translation, "Secretos de los éxitos de la naturaleza". Argos Vergara, Barcelona, 1984)
- HAKEN, Hermann: "Synergetics, the science of structure". Van Nostrand Reinhold, New York, 1984
- HAKEN, Hermann: "Information and Self-Organization" - Springer, Berlin, 1988
- HAKEN, H. & WUNDERLIN, A.: "Le chaos déterministe". La Recherche nr. 225, oct. 1990
- HAKEN, Hermann & WUNDERLIN, Arne: "Die Selbststrukturierung der Materie: Synergetik in der unbelebten Welt" - Vieweg, Wiesbaden, 1991
- HAKEN, Hermann: "Synergetics as a strategy to cope with complex systems". Proc. 2nd. Europ. Congr. Syst. Science, Praha, 1993
- HAKEN, Hermann: "Principles of Brain Functioning. A Synergetic Approach to Brain Activity, Behavior and Cognition" - Springer, Berlin, 1996
- HAKEN, H. & KNYAZEVA, H.: "Arbitrariness in nature: synergetics and revolutionary laws of prohibition" - J.Gen. Phi. Sc. 31(1), 2000a
- HAKEN, H. & KNYAZEVA, H.: "Synergetik zwischen Reduktionismus und Holismus" - Philosophie Naturalis, 37(1) 2000b
- HALL, A.D. & FAGEN, R.E.: "Definition of system". S.G.S.R. Yearbook, 1, 1956
- HALL, Arthur D. III: "Metasystems methodology: A new synthesis and unification". Pergamon, Oxford, 1989
- HALL, Brian: "Values shifts: a guide to personal and organizational transformation" - Twin Hights, Rockport, MA, 1995
- HALL, Edward: "The silent Language". Doubleday & Co., New York, 1959
- HALL, Edward: "The Hidden Dimension". Doubleday & Co., New York, 1966
- HALL, Edward: "Beyond Culture". Anchor Books, New York, 1977
- HALLIWELL, Jonathan: "Arcadia, anarchy and archetypes". New Scientist, nr. 1990, 1995
- HAMER, Mick: "Well connected" - N.Sc., Nr.2212, November 13th, 1999
- HAMEROFF, S.R., KASNAK, A. & SCOTT, A.C. (eds.): "Towards a science of consciousness" - MIT Press, Cambridge, Mass., 1996
- HAMEROFF, S.R. & PENROSE, R.: "Conscious events as orchestrated space-time selections" - J. Consc. St., 3 (1), p. 36-53
- HAMMOND, Deborah: "Historical perspectives on the ISSS: concluding reflections" - 42nd. Ann. Conf. of the ISSS, Georgia Technology Institute, Atlanta, 1998
- HANNEMAN, Robert A.: "Computer-assisted theory building. Modeling dynamic social systems" - Sage, Beverly Hills, 1988
- HANNEY, A.: "Human consciousness" - Routledge, London, 1990
- HANSELL, M.H.: "Animal architecture and building behavior" - Longmans, London, 1984
- HANSON, Barbara G.: "General systems theory beginning with wholes". Taylor & Francis, Washington, DC, 1995
- HANSON, J. & CRUTCHFIELD, J.: "Computational mechanics of cellular automata" - Physica D, 102, 1997
- HARARY, F. et al: "Structural models; an introduction to the theory of directed graphs" - Wiley, New York, 1965
- HARARY, Frank: "Graphical enumeration problems", in "Graph Theory and theoretical physics". Academic Press, New York, 1967
- HARAWAY, Donna J.: "Crystals, fabrics and fields: metaphors of organicism in 20th Century developmental biology" - Yale Univ. Press, New Haven, 1976
- HARDIN, Garrett: "The tragedy of commons". Science, 162, dec.13, 1968 (widely reprinted)
- HARDIN, Garrett: "Living on a lifeboat" - Bioscience, 24(10), 1974
- HARDIN, Garrett: "Exploring new ethics for survival: the voyage of the spaceship Beagle" - Penguin Books, New York, 1976
- HARDIN, Garrett: "Cultural carrying capacity: a biological approach to human problems" - Bioscience, 36(9), 1986
- HARDIN, Garrett: "Living within means: ecology, economics and population taboos" - Oxford Univ. Press, 1993

- HARDIN, Garrett: "Extensions of the tragedy of the commons"- Science, 280, 1998
- HARDY, C.: "Networks of meaning: a bridge between mind and matter" - Praeger, Westport, CT, 1998
- HARDY, Christine: "Self-organization, self reference and interinfluences in multilevel webs; beyond causality and determinism"- C&HK 8(3) 2001
- HARDY, Christine: "Multilevel Webs stretched across time: retroactive and proactive inter-influences"- SRBVS, 20(2) 2003
- HARE, V.C. Jr.: "Systems Analysis: a diagnostic approach". Harcourt & Brace, New York, 1967
- HARMAN, Willis: "Key choices of the next two decades". Fields within fields, 5 (1) 1972
- HARMAN, W.: "Global mind change- knowledge systems"- University of Indiana Press, Bloomington, Indianapolis, 1988
- HARMAN, W. & HORMAN, J. "Creative work"- Knowledge Systems, Indianapolis, 1990
- HARNAD, S.(ed.): "Categorical perception" - Cambridge Univ. Press, New York, 1987
- HARNDEN, Roger: "The language of Models". Syst. Pract., 3 (3) 1990
- HAROCHÉ, Serge: "Entanglement, decoherence and the quantum/classical boundary"- Physics Today, 51, July 1998
- HARRE, R.: "Varieties of realism: a rationale for Natural Sciences"- Blackwell, Oxford, 1986
- HARRE, R. & GILLET, G.: "The discursive mind" - Sage Publ., Thousand Oaks, 1994
- HARRI-AUGSTEIN, S. & THOMAS, L.F.: "Learning conversations"- Routledge, London, 1991
- HARRIS, Dorothy L.: Review of A.B. Cambel's "Applied chaos theory". Behav. Science, 39 (1) 1994
- HARRIS, R. & BUCHANAN, D.: "Managing in a dynamic environment"- Wolsey Hall, Oxford, 1998
- HARTH, Eric: "The Creative Loop: How the Brain makes a Mind". Addison Wesley, Reading, Massachusetts, 1995
- HARTLEY, R.V.L.: "Transmission of information". Bell Syst. Techn. J. 7 (p.535-63), 1928
- HARTNETT, W.E. (ed): "Systems: Approaches, theories, applications". Reidel, Boston, 1977
- HASKINS, Caryl: "Of ants and men"- Prentice Hall, N.Y., 1946
- HASSENSTEIN, B.: "Kybernetik und biologische Forschung". Athenaion, Frankfurt, 1966
- HASSENSTEIN, B.: "Biologische Kybernetik". Quelle und Meyer, Heidelberg, 1970
- HASSENSTEIN, B.: "Information and control in the living organism". Chapman & Hall, London, 1971
- HAUAN, Arnulf et al.: "Reaching out for Heterarchy". Cybernetics & Systems Research 92. World Scientific, Singapore, 1992
- HAUGELAND, J.(ed.): "Mind design: philosophy, psychology, artificial intelligence" - MIT Press, Cambridge, MA, 1981
- HAUGELAND, J. (ed.): "What is mind design"- MIT Press, Cambridge, MA., 1998
- HAUSER, M.D.: "The evolution of communication" - MIT Press, Cambridge, 1996
- HAWKEN, Paul: "The ecology of commerce" - Harper Collins, New York, 1993
- HAWLEY, A.H.: "Human ecology; a theoretical essay" - The Univ. Chicago Press, Chicago, Ill., 1986
- HAWTON, M.B.: "Essentials of a self-organizing system". Cybernetica, 17 (2), 1974
- HAYEK, Friedrich von: "Individualism and economic order" - Routledge & Keagan, London, 1949
- HAYEK, Friedrich von: "Theorie komplexer Phänomener" - Walter Eucken Institut Vorträge und Aufsätze, Bd 36, Verlag Mohr, Tübingen, 1972
- HAYES, Brian: "The Wheel of fortune". Amer. Scientist, 81 (2) 1993
- HAYES, Brian: "Graph Theory in Practice" - Amer. Sc., 88(1) Jan. 2000
- HAYES-ROTH, B.: "An architecture for adaptive intelligent systems" - Artificial Intelligence, 72, 1995
- HEBB, Donald O.: "The organization of behavior: a neurophysiological theory". J. Wiley, New York, 1941
- HEBEL, Misha: "Human values in technology"- Proc. 42nd ISSS Conf., Atlanta, 1998
- HEBEL, Misha: "Value systems; a way to greater understanding"- SPAR 11(4), 1998
- HEBEL, Misha: "World-Views as the Emergent Property of Human Value Systems" - SRBVS, Vol.16, Nr.3, 1999
- HECHT, Jeff: "IBM plans its latest smash hit" - N.Sc., Nr.2216, December 11th, 1999
- HEIDEGGER, M.: "Nietzsche, vol. 3 The will to power as knowledge and as metaphysics" - Harper & Row, S. Francisco, 1987
- HEIL, P. et al.: "Complex systems multilevel and multi-process approaches" in Weengart et al.(eds.)- Erlbaum, Mahwah, N.J., 1997
- HEIMS, S.: "John von Neumann and Norbert Wiener"- MIT Press, Cambridge, Mass., 1980
- HEIMS, Steve J.: "The cybernetic group". MIT Press, Cambridge, Mass., 1991
- HEJL, Peter: "Konstruktion der sozialen Konstruktion: Grundlinien einer konstruktivistischen sozialtheorie", in Watzlawick, Paul (ed): "Einführung in den Konstruktivismus" Piper, München, 1985
- HELLMANN, Kai-Uwe: "Systemtheorie und Neue Soziale Bewegung"- Westdeutscher Verlag, Opladen, 1996
- HEMPEL, C.G.: "General Systems Theory and the unity of science". Human biology, 23, 1951
- HENAND, Louis: "The metaphysical club: a story of ideas in America" - Farrar, Strauss & Giroux, New York, 2001
- HENNIN, Bernard de: "Conception et méthode dans la complexité". Proc. 2nd. Europ. Congr. Syst. Science, Praha, 1993
- HENRY, Charles & ROCHA, Luis Mateus: "Language theory: Consensual Selection of Dynamics" - C&S - Vol.27, Nr.6, 1996
- HERBST, D.P.: "What happens when we make a distinction; an introduction to co-genetic logic" - C&HK.2 (1) 1993
- HERKEN, R.: "The universal Turing Machine: a 50 years survey" - Oxford Univ. Press, Oxford, 1988
- HERMAN, R. & PRIGOGINE, I.: "A two fluids approach to town traffic". Science, 204 (p.148-51)
- HERMANN, A. & ALLEN, J.K.: "The development of a sustainable system under uncertainty"- Proceed. 42nd ISSS Meeting, Atlanta, 1998
- HERRSCHER, Enrique: "Cause-effect loops as explanation of underdevelopment"- Hum. Syst. Manag., 7, 1988
- HERRSCHER, Enrique: "Mutual causality in developing countries"- Syst.Pract., 1(3) 1988
- HERRSCHER, Enrique: "The waves-tide model". IFSR Bulletin, (23) 1989
- HERRSCHER, Enrique: "An agenda for enhancing systems thinking in society". Syst. Research, 13 (2) 1996
- HERRSCHER, Enrique: "A systems approach to business ethics" - Proc. 42nd ISSS Conference, Atlanta, 1998
- HERRSCHER, Enrique: "Pensamiento sistémico; cambiar el camino o caminar el cambio"- Granica, Buenos Aires, 2003
- HERSHEY, Daniel: "Aging of cities, corporations and civilizations". Syst. Research, 3 (1) 1986
- HERSHEY, Daniel: "Evolving systems: entropy, aging and death", in G.P. Scott (ed): "Time, Rhythms and chaos". Iowa State Univ. Press, Ames, 1991
- HETEBRIJ, M. & NIJSSEN, M.: "Reappearing knowledge" in G. de Zeeuw (ed.): Knowledge (dis)appearance. Systeem Groep Nederland, Delft Univ. Press, 1986
- HEYLIGHEN, Francis: "Causality as distinction conservation". Cyb. & Systems, 20 (5) 1989
- HEYLIGHEN, Francis: "Classical and nonclassical representations in physics. 1:Physics". Cyb. & Systems, 21 (4) 1990a
- HEYLIGHEN, Francis: "Classical and nonclassical representations in physics. 2:Quantum mechanics". Cyb. & Systems, 21 (5) 1990b
- HEYLIGHEN, Francis: "Cognitive levels of evolution", in F. Geyer (ed); "The Cybernetics of complex systems". Intersystems, Salinas, 1991
- HEYLIGHEN, Francis: "Principles of systems and cybernetics: an evolutionary perspective". Cybernetics & Systems '92, vol.1. World Scientific, London, 1992a
- HEYLIGHEN, Francis: "Evolution, Selfishness and cooperation". J.of Ideas, 1992b
- HEYLIGHEN, Francis: "Metasystem as constrained variation". World Futures, 45, 1995
- HEYLIGHEN, Francis: "Selection criteria for the evolution of knowledge". 13th. Intern. Congress on Cyb., Namur, 1995
- HEYLIGHEN, Francis & BOLLEN, Johan: "The World Wide Web as a Super-brain: From Metaphor to Model". 13th. Cyb. and Systems Conf., Vienna, 1996
- HEYLIGHEN, Francis: "Objective, subjective and inter-subjective selectors of knowledge"- Evolution and Cognition, 3 (1) 1997
- HEYLIGHEN, Francis: "Publications on Complex, Evolving Systems: A Citation-Based Survey" - Complexity, 2, (5), 1997
- HEYLIGHEN, Francis: "What makes a meme successful? Selection criteria for cultural evolution".- Proc.15th Internat.Congress of Cybernetics- Ass.I-Internat.de Cybernetique, Namur, Belgium, 1998
- HEYLIGHEN, Francis et al.(eds.): "The evolution of complexity" - Kluwer, Dordrecht, 1999
- HEYLIGHEN, Francis: "Memes and evolution of cooperation". (Personal communication)
- HIGASHI, M. & BURNS, T.P. (eds.): "Theoretical studies of ecosystems: the network perspective" - Cambridge University Press, New York, 1991
- HILDUM, Donald C.: "The missing dimension of specialization". Syst. Research, 8 (3) 1991

- HILGARD, E.R.: "Divided Consciousness: Multiple Controls in Human Thought and Action" - Wiley, New York, 1977
- HILGRAM, N. & ATLAN, Henri: "Probabilistic automata as a model for epigenesis of cellular networks". *J. of Theor. Biology* 103 (p.523-47)
- HILLIER, Bill & HANSON, Juliette: "The Social Logic of Space" - Cambridge Univ. Press, 1984
- HILLIER, Bill: "Space is the Machine" - Cambridge Univ. Press, 1996
- HILLIS, W.D.: "The connection machine: a computer architecture based on cellular automata", *Physica* 10D, 1984
- HILLIS, W.D.: "The connection machine". MIT Press, Cambridge, Mass., 1985
- HINDE, R.A. & GROEBEL, J. (eds.): "Cooperation and prosocial behavior" - Cambridge, U.P., Cambridge, 1991
- HINTON, Geoffrey E.: "How neural Networks learn from experience". *Sc. American*, 267 (3) 1992
- HIRSCHHEIM, R. & KLEIN, H.K.: "Paradigmatic influences on information systems development methodologies evolution and conceptual advances" - in YOVITZ, M. (Ed.): "Advances in Computers", vol 33 - Academic Press, New York, 1992
- HITCHINS, Derek K.: "Putting Systems to Work" - Wiley, New York, 1992
- HO, M. & SAUNDERS, P.T.: "Beyond neo-darwinism: an epigenetic approach to evolution" - *J. Theor. Biol.*, 78, p. 573-591, 1979
- HOBBS, T.: "Leviathan" (in J.SOMMERVILLE & R.E. SANTONI (eds.) "Social and Political philosophy" - Doubleday, New York, 1963 (orig. work publ. 1651)
- HOFBAUER, J. & SIGMUND, K.: "Evolutionstheorie und dynamische Systeme: Mathematische Aspekte der Selektion" - Paul Parey, Berlin, 1984
- HOFFERBERT, R.I. & SCHAFFER, G.F.: "The application of General Systems Methodology to the comparative study of public policy" - *Int.J.Gen.Syst.*, 8, 1982, p. 93-108
- HOFFMEISTER, Wilhelm: "Allgemeine Morphologie der Gewächse". Engelmann, Leipzig, 1868
- HOFFMEYER, J. & EMMECHE, C.: "Code duality and the semiotics of nature" - (See in Anderson & Merrell (eds.) *On semiotic modeling* - Mouton de Gruyter, Berlin, 1991
- HOFFMEYER, Jesper: "Signs of meaning in the universe" - Indiana Univ. Press, Bloomington/Indianapolis, 1993
- HOFFMEYER, Jesper: "The swarming cyberspace of the body" - *C&HK*, 3(1), 1995
- HOFFMEYER, Jesper: "Surfaces inside surfaces: on the origin and agency of life" - *C&HK* 5(1)1998
- HOFSTADTER, Douglas: "Thoughts that count (on Fodor's and Pinker's divergent views)" - *N.Sc.*, 2269, Dec.16th 2000
- HOFSTADTER, R. : "Social Darwinism in American Thought" - Univ. of Pennsylvania Press, Philadelphia, 1945
- HOGG, T. & HUBERMAN, B.A.: "Better than the best: the power of cooperation" - Addison Wesley, Reading, 1992
- HOLCOMBE, M. & PATON, R.C.: "Information processing in cells and tissues" - Plenum Press, New York, 1998
- HOLDEN, A.V. (Ed.): "Chaos" - Princeton Univ. Press, 1986
- HOLENSTEIN, Elmar (ed.): "Semiotik: Ausgewählte texte 1919-82" - Suhrkamp, Frankfurt a/M., 1988
- HOLLAND, J.H. et al: "Induction: Processes of Inference, Learning and Discovery" - M.I.T. Press, Cambridge, Mass, 1986
- HOLLAND, John: "Adaptation in natural and artificial systems" Univ. of Michigan Press, Ann Arbor, MI, 1975 (revised edition 1992)
- HOLLAND, John H.: "Complex Adaptive Systems" - *Daedalus*, Vol. 121, 1, p.17-30, 1992
- HOLLAND, John H.: "Genetic algorithms" - *Sc.Amer.*, Jul.1992
- HOLLAND, John H.: "Hidden Order: How adaptation builds complexity" - Addison-Wesley, Redwood City, Ca, 1996
- HOLLAND, John H.: "Emergence: from chaos to order" - Helix Books, 1998
- HOLLAND, John H.: "Emergence" - Oxford Univ. Press, Oxford, 2000
- HOLLEBONE, B. & HOUGH, R.R.: "Freedoom and Limits: the fundamental theorem of system structure". *Syst. Research*, 8 (3) 1991
- HOLLING, C.S. & GOLDBERG, M.A.: "Ecology and Planning". *J. Amer. Inst. Planners*, 37 (4) 1971
- HOLLING, C.S.: "Resilience and stability of Ecosystems", in Jantsch, E. & Waddington, C. (eds): *Evolution and Consciousness*. Addison Wesley, London, 1976
- HOLLING, C.S.: "The Resilience of terrestrial ecosystems", in Clark, W.C & Munn, R.E. (eds): *Sustainable development of the biosphere*. Cambridge Univ. Press, 1986
- HOLLOWAY, Ralph H. Jr.: "The evolution of the human brain" *SGSR Yearbook*, 12, 1966
- HOLMBERG, Stig (ed.): "Systemic research on competence and competence development in small and medium size enterprises" (a collection of papers)- *SRBVS*, 18(2) 2001
- HOLMES, Robert: "Beyond words" - *N.Sc.*, Nr.2194, July 10th, 1999
- HOLZNER, Burkart: "Reality construction in society". Schenkmann, Cambridge, Mass., 1968
- HONNETH, A. & JOAS, H. (eds.): "Communicative action: essays on Jürgen Habermas's theory of communicative action" - The MIT Press, Cambridge, 1991
- HONNETH, A. et al. (eds.): "Cultural-political interventions in the unfinished project of enlightenment" - The MIT Press, Cambridge, 1992
- HOOKE, C.A.: "Reason, regulation and realism: toward a naturalistic regulatory systems theory of reason" - New York Univ. Press, Albany, N.Y., 1995
- HOOKWAY, C.: "Naturalized epistemology and epistemic evaluation" - *Inquiry* 37, p. 465-485
- HOOPES, James (ed.): "Peirce on Signs". Chapel Hill, North Carolina Univ. Press, 1991
- HOOS, Ida: "Systems analysis in public policy: a critique". Univ. of California Press, Berkeley, 1972
- HOPPERT, Michael & MAYER, Frank: "Prokaryotes" - *Amer. Sc.*, V.87, (6), November-December 1999
- HORENSTEIN, M.: "Du behaviorisme au connexionisme: une continuité épistémologique". *Rev. Intern. de Systémique*, 4 (3) 1990
- HORGAN, John: "Profile: reluctant revolutionary". (T.S. Kuhn). *Sc. American*, 264 (5) 1991
- HORGAN, John: "Last words of a quantum heretic". *New Scientist*, 137 (1862) 1993
- HORGAN, J. : "The new social Darwinists" - *Sc. Amer.*, Oct., p. 174-181, 1995
- HORKHEIMER, M. & ADORNO, T.W.: "Dialectic of enlightenment" - Continuum, New York, 1993
- HORN, Robert E.: "Visual Language" - MacroVU Press, Bainbridge Island, Washington, 1998
- HORNUNG, Bernd H.: "In Memoriam Niklas LUHMANN - 1927-1998" - International Sociological Association, Bull. 78-79, Spring 1999
- HORVATH, Fred E.: "Psychological stress: a review of definitions and experimental research". *SGSR Yearbook* 4, 1959
- HOUGH, Robin R (ed): "The impact of socialization and specialization on society". *Syst. Research, Special issue*, 8 (3) 1991
- HOUGH, R. & HOLLEBONE, B.: "Organizational structure defining process management". *Cyb. & Systems Research '92*, World Scientific, Singapore, 1992
- HOUGHTON, John: "Global warming: the complete briefing" - Cambridge Univ. Press, Cambridge, MA., 1997
- HOUTEN, Hajek van: "Spel van Grenzen en Niveaus" (in dutch)(Play on borders and levels)- *Systemica*, Utrecht, Nederland, 1982
- HOWARD, William A.: "Peirce's influence on today's mathematical logic" - *C. & HK.*, 8, (1-2), 2001
- HOWE, R.H. & von FOERSTER, H.: "Introductory comments to F. Varela's calculus for self-reference". *Intern. J. Gen. Systems*, 2 (1) 1975
- HOWE, Richard H.: "Some problems of a social cybernetics". *ASC Cyb. Forum*, VII (2), 1975
- HOWLAND, Daniel: "Cybernetics and General Systems Theory". *SGSR Yearbook*, 8, 1963
- HUBBELL, Stephen P.: "The unified neutral theory of biodiversity and biogeography" - Princeton Univ. Press, 2001
- HUBERMAN, B.A. (ed.): "The Ecology of computation". North Holland, Amsterdam, 1988
- HUET, B.: "Contribution à l'étude de l'isomorphisme dans les systèmes complexes, à partir des systèmes biologiques et de caractères extraits par Forrester" - *Kybernetes*, 10, 1981, p. 43-49
- HUGGINS, W.H.: "An Algebra for signal representation". *SGSR Yearbook*, 8, 1963
- HUGHES, Donald J.: "Ecology in ancient civilizations" - Univ. of New Mexico Press, Albuquerque, N.M., 1975
- HUMBOLDT von, Wilhelm: "On language: the diversity of human language, structure and its influence on mental development of mankind" (orig. in German, 1836) - P. Heath (transl.) - Cambridge Univ. Press, Cambridge, MA, 1988
- HUNT, M.: "How science takes stock: the story of meta-analysis" - Russell Sage Foundation, New York, 1997
- HUSSERL, E. : "The crisis of European sciences and transcendental phenomenology" - North Western Univ. Press, Evanston, Ill., 1970
- HUT, P.: "Theory and experiment in philosophy" - *J.Consc.Stud.*, 6, 1999
- HUTCHINS, C.L.: "Systemic thinking: solving complex problems" - Professional development systems, Aurora, CO, 1996
- HUXLEY, Julian D.: "Problems of relative growth". Dover Publ., New York, 1972

- HYLAND, K.: "Talking to the academy: forms of hedging in science research articles" - Written Commun., Apr. 1996
- IBERALL, A.S.: "Toward a general science of viable systems". Mc Graw Hill, New York, 1972
- IBERALL, A.S.: "Cybernetics and the Thermodynamics of Systems". ASC Cyb. Forum, 5 (2) 1973
- IBERALL, A.S.: "On visual self abuse". ASC Cyb. Forum, 7 (2) 1975
- IEEE: "Proceedings on adaptive systems". Special issue, 1976
- INCE, D.C.(Ed.): "Collected Works of Alan Turing: Mechanical Intelligence" - Elsevier, 1992
- INDURKHA, B.: "Metaphor and cognition" - Kluwer, Dordrecht, 1992
- INTRONA, Lucas D.: "Language and social autopoiesis" - C&HK, 5(3) 1998
- IRION, Robert: "Say the magic words" - N.Sc. nr. 2294, Jun.9, 2001
- IRVINE, William S.: "A review of GREENSPAN, Donald: Discrete Models". Intern. J. Gen. Systems, 4 (2) 1978
- ISAACSON, R.L.: "The Limbic System" - Plenum Press, New York, 1982
- ISRAEL, Giorgio: "L'histoire du principe du déterminisme et ses rencontres avec les mathématiques", in Dahan Dalmedico, A. et al. (eds): "Chaos et déterminisme" Le Seuil, Paris, 1992
- ISRAEL, Giorgio: "La Mathématisation du Réel" - Odile Jacob, Paris, 1996
- ISSELSTEIN, F.: "Ordnungsentstehung und Gestaltung. Beiträge zu einer ökonomischen Systemtheorie" - Boterman & Boterman, Köln, 1994
- ITO, M. (ed.): "Brain and mind" - Elsevier, Amsterdam, 1997
- IVANOV, K.: "Critical systems thinking and information technology" - J. Appl. Syst. Anal., 18, 1991
- JABLANKA, E. & LAMB, M.: "Epigenetic inheritance and evolution: the Lamarckian dimension" - Oxford Univ. Press, Oxford, 1995
- JACKENDORFF, R.: "Consciousness and the computational mind" - MIT Press, Cambridge, 1987
- JACKENDORFF, R.: "Semantics and cognition" - MIT Press, Cambridge, 1993
- JACKSON, E.A.: "No provable limits to "scientific knowledge" - Complexity 1(2), 1995
- JACKSON, M. & KEYS, P.: "Towards a system of systems methodologies" - J. Oper. Res., 35, 1984
- JACKSON, Michael C.: A review of R. TRAPPL (ed): "Power, Autonomy". Syst. Pract., 1 (1) 1988
- JACKSON, Michael C.: "Systems methodologies as complementary tools for managing situational complexity". Transac. Inst. of Measur. and Control, 10 (3), 1988
- JACKSON, Michael: "Systems methodology for the management sciences" - Plenum Press, New York, 1991
- JACKSON, Michael C.: "The principles, practice and philosophy of systems education". Cyb. & Systems, 22 (2), 1991
- JACKSON, Michael C.: "Critical Systems Thinking", in Banathy, B. & Rodriguez Delgado, R. (eds.): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- JACKSON, Michael C.: "Systems methodology for the management sciences". Proc. 2nd. Europ. Congr. Syst. Science, Praha, 1993
- JACKSON, Michael C.: "Beyond the Fads: Systems thinking for managers". Syst. Research, 12 (1) 1995
- JACKSON, Michael: "Towards coherent pluralism in Management science" - Working Paper Nr.16, Lincoln School of Management, Lincoln, England, 1997
- JACKSON, Michael: "Systems science today and its contribution to sustainable technology" - Proceed. 42nd ISSS Meeting, Atlanta, 1998
- JACKSON, Michael: "Peter Checkland at 70: a review of soft systems thinking (a special issue including two new papers by Checkland and the full list of his publications)" - SRBVS, 17(5.1), 2000
- JACKSON, Michael: "Creative holism: systems thinking for managers" - Wiley, London, 2003
- JACOB, François: "The possible and the actual" - Pantheon Books, New York, 1982 (original in french)
- JACOBSON, H.: "Information, reproduction and the Origin of Life". Amer. Scientist, 43 (1), 1955
- JACQUARD, Albert: "Eloge de la différence". Seuil, Paris, 1978
- JACQUARD, Albert: "De l'angoisse à l'espoir: leçons d'écologie humaine". Calmann Lévy, Paris, 2002
- JACQUES, F.: "Dialogiques: recherches logiques sur le dialogue" - Presses Univ. de France, Paris, 1979
- JAMES, D.B.: "Addendum to "The unfolded Shape of the Brain" Kybernetes, 22 (5), 1993
- JAMES, L.R. et al.: "Causal analysis-assumptions, models and data. - Sage, Beverly Hills, 1982
- JAMMER, Max: "Concepts of Space". Harvard Univ. Press, 1957
- JANES, F.R.: "Interpretive structural modelling". Transact. Inst. of Measur. and Control, 10 (3), 1988
- JANTSCH, Eric: "Design for Evolution". Braziller, New York, 1975
- JANTSCH, E. & WADDINGTON, C.H. (eds): "Evolution and Consciousness". Addison Wesley, Reading, Mass., 1976
- JANTSCH, Eric: "The self-organizing universe". Pergamon, Oxford, 1980
- JANTSCH, Eric: "The unifying paradigm behind dissipation structures, autopoiesis, hypercycles and ultracycles". Univ. of California, Berkeley, CA, 1980
- JANTSCH, E.: "Autopoiesis: a central aspect of dissipative self-organization" - in ZELENY, 1981.
- JANTSCH, Eric (ed): "The evolutionary vision: Towards a unifying paradigm". Westview Press, Boulder, CO., 1981
- JANTSCH, Eric: "From self-reference to self-transcendence: the evolution of self-organization dynamics", in Schieve, W. & Allen, P.M.(eds): "Self-organization and dissipative structures". Univ. of Texas, Austin, 1982
- JAQUES, E.: "The Development of Intellectual Capability: A Discussion of Stratified Systems Theory" - The Journal of Applied Behavioral Science, V.22, Nr.4, 1986
- JARAYATNA, N.: "Understanding and evaluating methodologies" - Mc Graw Hill, London, 1994
- JAROS, G. & CLOETE, A.: "Biomatrix: the web of life" - World Futures, V. 23, 1987
- JAROS, G.G.: "Teleonics: a process based systems approach". IFSR Newsletter, (34/35), 1994
- JAROS, György: "Teleonics: the primacy of process" - Patterns Newsletter, Barbara Vogl (ed.)- Soquel, CA., May 1996
- JAROS, György: "Living systems theory of J.G. Miller and teleonics" - 42nd. Conf. of the ISSS, Georgia Technology Institute, Atlanta, 1998
- JAROS, G. & DOSTAL, E.: "A teleonic management framework for organizations" - SPAR, 12 (2), 1999
- JAROS, György: "The living systems, theory of James G. Miller and Teleonics" - SRBVS, 17(3), 2000
- JAYNES, J. : "The origin of consciousness in the breakdown of the bicameral mind" - Houghton Mifflin, Boston, 1976
- JDANKO, Alexis V.: "An evolutionary cybernetic theory of knowledge and cognition". Cyb. & Systems, 22 (6), 1991
- JDANKO, Alexis V.: "An Evolutionary and Entropic Interpretation of Information". Kybernetes, 23 (9), 1994
- JEFFERS, John N.R.: "An Introduction to Systems Analysis: with ecological applications". E. Arnold, London, 1978
- JEFFERYS, W. & BERGER, J.O.: "Ockam's Razor". Amer. Scientist, 80 (1), 1992
- JELDTOT JENSEN, Henrik: "Self-organized Criticality: Emergent Complex Behavior in Physical and Biological Systems" - Cambridge Univ. Press, New York, 1998
- JENKS, C.L.: "Evaluating educational system design" - SRBVS, 15(3), 1998
- JENLINK, PATRICK M.: "Designing educational systems for the 21st century" - SRBVS 18(3) 2001
- JENLINK, P. & BANATHY, B.H.: "The Agora Project: the new Agoras of the 21st. century" - SRBVS, 19(5), 2002
- JENSEN, Finn V.: "An introduction to Bayesian networks" - UCL Press, 1995
- JENSEN, Roderick V.: "Classical Chaos". Amer. Scientist, 75 (2) 1987
- JERISON, H.J. & I.: "Intelligence and Evolutionary Biology". NATO ASI Series. Springer, Berlin, 1980
- JIAVIN, M.: "Transformation in the Chinese cognitive map" - In LASZLO & MASULLI, p. 221-236, 1993
- JINGCAI HAN: "A framework of value- Focused systems thinking" - SPAR, 13(1), 2000
- JOAS, H.: "The unhappy marriage of hermeneutics and functionalism" - In HONNETH & JOAS, p. 97-118, 1991
- JOHANNESSEN, Joh. A.: "The holographic Organization - a design model". Cyb. & Systems, 22 (1) 1991
- JOHANNESSEN, J.A. & HAUAN, A.: "Reaching out for Heterarchy". Cyb. & Systems, 23 (2) 1992
- JOHANNESSEN, J.A. & HAUAN, A.: "Linking Network Organization to Holographic Design: Future Industrial Organization". Kybernetes, 22 (4) 1993
- JOHANNESSEN, J.A. & HAUAN, A. : "Communication - A systems theoretical point of view (third order cybernetics) Syst. Pract., 7 (1), 1994, p. 63-73
- JOHANNSEN, Jörgen Dines: "Dialogic semiotic; a essay on signs and meaning" - Indiana Univ. Press, Bloomington, 1993
- JOHANSEN, Mikkel W.: "When will we become robots?" C&HK, 9 (3-4) 2002
- JOHANSEN BERTOGLIO, Oscar: "Introducción a la Teoría General de Sistemas". Limusa, Mexico, 1985

- JOHNSON, David K.: "Reclaiming reality: a critique of Maturana's ontology of the observer" - *Methodologia*, 9(5) 1991
- JOHNSON, David K.: "The metaphysics of constructivism" - *C&HK*, 1(4), 1993
- JOHNSON, David K.: "The view from somewhere: a philosophical critique of radical constructivism" - *C&HK*, 3(4), 1996
- JOHNSON, Gary R.: "Does information exist?" - *Proc. ISSS Meeting*, Denver, 1992
- JOHNSON, M.: "The body in the mind; the bodily basis of meaning, imagination and reason" - Chicago Univ. Press, Chicago, 1987
- JOHNSON, Steven: "Emergence: the connected lives of ants, brains, cities and software" - Scribner/Allen/Lane/Penguin, New York, 2002
- JOHNSON-LAIRD, P.N.: "Mental models" - Cambridge Univ. Press, Cambridge, U.K., 1983
- JOHNSON-LAIRD, P.N.: "The computer and the Mind" - Harvard Univ. Press, Cambridge, Mass., 1988
- JOHNSTONE, Christopher: "General systems thinking and community-based rehabilitation" - *SPAR*, 16(2) 2003
- JONAS, Hans: "Comment on G.S. Theory". *Human Biology* 23, 1951
- JONES, Barry: "Dictionary of World Biogeography". Information Australia, 1994
- JONES, C.J.: "Design methods: seeds of human futures" - Wiley, New York, 1980
- JONES, D.S.: "Cybernetics and General Systems Theory: A unitary science?". *Kybernetes*, V. 8 (1), 1979. Note: Other essays on this topic in the same issue
- JONES, R.G. & BRANDL, G. (eds): "Unity and diversity in Systems", Braziller, New York, 1969
- JONES, R.W.: "Principles of biological regulation" - Academic Press, New York, 1973
- JONG Heon Beyon: "Non-Equilibrium Thermodynamic Approach to the Change in Political Systems" - *SRBVS*, Vol.16, Nr.3, 1999
- JORNA, R.J., van HEUSDEN, B. & POSNER, R. (eds.): "Signs, search and communication: semiotic aspects and artificial intelligence" - De Gruyter, Berlin, 1993
- JOSEPHSON, B.D.: "Constructional tools as the origin of cognitive capacities" - *CASYS J.*, 7, Liège, 2000
- JOSEPHSON, D.R. & JOSEPHSON, S.G.: "Abductive inference: computation, philosophy, technology" - Cambridge Univ. Press, Cambridge, 1994
- JOSLYN, Cliff: "On the semantics of entropy measures of emergent phenomena". *Cyb. & Systems*, 22 (6) 1991
- JOSLYN, C. et al.: "Synopsis of the Principia Cybernetica Project". *Proc. 13th Internat. Congr. Cybernetics*, Namur, 1992
- JUDGE, Anthony J.N.: "Transdisciplinarity-3 as the emergence of patterned experience; transcending duality as the conceptual equivalent of learning to walk". 1st World Congress of Transdisciplinarity, Arabida, Portugal, 1994
- JUDGE, Anthony J.N.: "Envisaging the art of navigating conceptual complexity; in search of software combining artistic and conceptual insights". *Knowl. Organization*, 22 (1) 1995
- JUDSON, Horace Freeland: "Eight day of creation" - Simon & Schuster, New York, 1979
- JUMARIE, Guy: "Thermodynamics of irreversible systems and subjectivistic selective systems: Inferences via relativistic information". *Cybernetica*, XXV (4) 1982
- JUMARIE, Guy: "Subjectivité, Information, Système: Synthèse pour une cybernétique relativiste". Univers, Montréal, 1980 (English translation: "Subjectivity, Information, Systems". Gordon & Breach, New York, 1986)
- JUMARIE, Guy: "Relative information" - Springer, Heidelberg, 1987
- JUNG-CHAN, Pauline P.L.: "Learning from an action experiment" - *C&HK*, 7 (2-3) 2000
- JUNGER, Ernst: "Heliopolis". (A novel, french translation) Plon, Paris, 1952
- JUST-HAHN, K. & HERRMANN, T.: "Step-by-step: self-organized co-ordination within work flow management systems" - *C&HK*, 6(2), 1999
- JØRGENSEN, S.E. (ed.): "Thermodynamics and ecological modelling" - Lewis Publ., Boca Raton, FL, 2001
- KADANOFF, Leo P.: "From order to chaos: critical, chaotic and otherwise" - World Scientific, Singapore, 1993
- KAHLER, Erich: "The Desintegration of Form in the Arts" - Braziller, New York, 1968
- KAHNEMAN, D. & TVERSKY, A.: "Choices, values and frames" - Cambridge University Press, New York, 2000
- KALAJDIEVA, Magdalena A.: "Perceptual motor arch with decision making levels" - IFAC, 1999
- KALAJDIEVA, Magdalena, A.: "Design procedures for a data base for systems science" - *Proc. 15th Cyb. & Syst. Meet.*, Austrian Soc.Cyb. Studies, Vienna, 2000
- KALAJDIEVA, Magdalena, A.: "Experience in knowledge management for leadership in science and education" - 9th IDIMT-ZADOV (Czech. Rep.) 2001
- KALAJDIEVA, Magdalena A.: "Exploring the unknown needs organized integrity" - *Proc. 16th Meet. of Cybernetics and Systems*, Vienna, 2002
- KALIL, R.E.: "Synapse Formation in the developing Brain". *Sc. American*, 261 (6), 1989
- KALMAN, R.E., FALB, P.L. & ARBIB, M.: "Topics in mathematical systems theory". Mc Graw Hill, New York, 1969
- KALMUS, H. (ed): "Regulation and control in living systems". Wiley, New York, 1966
- KAMARIT, J.: "Die Bedeutung der Theorie des offenen System in der gegenwärtigen Biologie". *Deut. Zeit. für Phil.*, 9, 1961
- KAMPIS, G. & CSANYI, V.: "Replication is informational". *J. Soc. Biol. Struct.*, 1986
- KAMPIS, György: "Some problems of systems description: I. Function; II. Information". *Inter. J. of Gen. Systems*, 13, 1987
- KAMPIS, G. & CSANYI, V.: "Replication in abstract and natural Biosystems", 20, (p.143-52), 1987
- KAMPIS, György: "On information and autonomy". *Rev. Intern. de Systémique*, 2 (3), 1988
- KAMPIS, György: "On the modelling relation". *Syst. Research*, 5 (2), 1988
- KAMPIS, György: "On problems of Self-organization", in Dalenoort, G.J.(ed): "The Paradigm of self-organization". Gordon & Breach, New York, 1989
- KAMPIS, György: "Self-modifying systems: A new framework for dynamics, information and complexity". Plenum Press, New York, 1990
- KAMPIS, G.: "Self modifying systems in biology and cognitive science" - Pergamon, Oxford, 1991
- KAMPIS, G.: "On understanding how the mind is organized: cognitive maps and the "physics" of mental information processing" - in LASZLO & MASULLI, 1993, p. 135-150
- KAMPIS, G.: "Self-modifying systems: A model for the constructive origin of information" - *Biosystems* 38(2/3), 1996
- KANDEL, E.R. & HAWKINS, R.D.: "The biological basis of learning and individuality". - *Sc. Amer.*, 267(3), 1992
- KANERVA, Pentti: "Sparse distributed memory". MIT Press, Cambridge, Mass., 1988
- KANGAS, Patrick et al.: "Modeling dangerous ideas: the energetics of revolution" - *Proc. 42nd ISSS Conf.*, Atlanta, 1998
- KANIZSA, G.: "Organization in vision: Essays on Gestalt perceptions" - Praeger, New York, 1979
- KANUNGO, S. et al.: "A Structured Model for Evaluating Information Systems Effectiveness" - *SRBVS*, Vol.16, (5), 1999
- KAPLAN, Frédéric: "La naissance d'une langue chez les robots" - Hermès, Paris, 2001
- KARATAY, V. & DENIZHAN, Y.: "The non-decreasing character of complexity: a biological approach" - *Int. J. Comp. Antic. Syst.*, 5, Univ. of Liège, 2000
- KARGL, Walter: "Handlung und Ordnung im Strafrecht". Duncker & Humblot, Berlin, 1991
- KARIM, Ahmed A.: "Unified field theory, symmetry breaking and the emergence of order" - *CASYS J.*, 2, Inst. of Math., Univ. of Liège, Belgium, 1998
- KARSKY, Michael: "La Dynamique des Systèmes ou la Systémique de l'ingénieur". *Proc. 2nd. Eur. Congr. of Systems Sciences*, Praha, 1993
- KARSKY, MICHEL: "La dynamique des systèmes complexes ou la Systémique de l'ingénieur" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- KASABOV, Nikola: "Foundations of neural networks, fuzzy systems and neural engineering" - MIT Press, Cambridge, MA, 1996
- KAST, F. & ROZENZWEIG, J.: "Organization and management: A systems approach". Mc Graw Hill, New York, 1974
- KASTELEYN, P.W.: "Graph theory and crystal physics", in "Graph theory and theoretical physics". Academic Press, New York, 1967
- KATCHALSKY, A. & CURRAN, P.F.: "Non equilibrium thermodynamics in Biophysics". Harvard Univ. Press, 1967
- KATCHALSKY, A. & CURRAN, P.F.: "Nonequilibrium Processes in Biology" - Harvard Univ. Press, Cambridge, MA, 1967
- KATCHALSKY, A.: "Thermodynamic of flow and biological organization". *Zygon*, 6, 1971
- KATCHALSKY, A.: "Thermodynamics and Life". *Proc. Int. Union of Physiol. Sciences*, 8, 1971
- KATSELENINBOIGEN, A.: "Change and evolution". *Syst. Research* 1 (4) 1991
- KATSELENINBOIGEN, A.: "Selected topics in indeterministic systems". Intersystems, Seaside, CA, 1988

- KATSENELINBOIGEN, A.: "Vertical and horizontal mechanisms as a systems phenomenon". Intersystems, Seaside, CA, 1988
- KATUS, J. et al. (eds.): "Andragologic in transformation" (in Dutch)- Boom, Amsterdam, 1998
- KATZ, D. & KAHN, R.L.: "Social psychology of organizations". Wiley, New York, 1966
- KATZ, D. & KAHN, R.L.: "Common characteristics of open systems", in Emery, F.E. (ed): "Systems Thinking". Penguin, Harmondsworth, 1969
- KATZ, Stuart: "An Analysis of the theory of knowledge in Power's model of brain". ASC Cyb. Forum 8 (1-2) 1976
- KAUFFMAN, Louis H.: "Network synthesis and Varela's calculus". Intern. J. Gen. Systems, 4 (3) 1977
- KAUFFMAN, Louis H.: "Knots and applications" - World Scientific, Singapore, 1994
- KAUFFMAN, Louis H.: "Ways of the game: play and position play"- C&HK, 2(3), 1994
- KAUFFMAN, Louis H.: "Virtual logic (a series started in 1997)"- C&HK, 1997-2001
- KAUFFMAN, Louis H.: "Virtual logic: the matrix"- C&HK, 6(3) 1999
- KAUFFMAN, Louis H.: "Cybernetics of fixed points" - C&HK, 8, (1-2), 2001
- KAUFFMAN, Louis H.: "The mathematics of Charles Sanders Peirce"- C&HK, 8 (1-2) , 2001
- KAUFFMAN, Louis H.: "Laws of form and form dynamics"- C&HK, 9 (2), 2002
- KAUFFMAN, Stuart A.: "Metabolic stability and epigenesis in randomly constructed genetic nets". J. Theor. Biol., 22, 1969
- KAUFFMAN, S.A. & VARELA, F.: "Form dynamics"- J. Soc. & Biol. Struct., 1980
- KAUFFMAN, Stuart A.: "Emergent properties in random complex automata". Physica 10D, 1984
- KAUFFMAN, Stuart A.: "Antichaos and adaptation". Sc. American. 265 (2), Aug. 1991
- KAUFFMAN, Stuart A.: "The origins of order: self organization and selection in evolution". Oxford Univ. Press, 1993
- KAUFFMAN, Stuart A.: "At Home in the Universe: The Search for the Laws of Self-organization and Complexity"- Oxford Univ. Press, New York, 1995
- KAUFFMAN, S.A. & WEISS, CHR.: "The key to Frege"- C&HK, 8 (4), 2001
- KAUFFMAN, L.H. & BRIER, S.: "Peirce and Spencer Brown: history and synergies in cybersemiotics" - C&HK, 8, (1-2), 2001
- KAUFMAN, Gianni: "Il Sistema globale: Immagini e Modelli". del Bianco, Udine, 1974
- KAUFMANN, A.: "Des points et des flèches". Dunod, Paris, 1970
- KAUFMANN, A.: "Introduction à la théorie des sous-ensembles flous: 1. éléments théoriques de base". Masson, Paris, 1973 (In English: "Introduction to the theory of fuzzy subsets". Academic Press, New York, 1975)
- KAY, Robert & HALPIN, Darren: "Redefining the Role of the Practitioner in Critical Systems Methodologies" - SRBVS, 16, (3), 1999
- KAY, Robert: "Are organizations autopoietic? A call for new debate"- SRBVS, 18(6), 2001
- KEATON, A.E.: "Promoting group synergy", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- KEE, B. & STOEP, Jan van der: "Hypermobility: a challenge for systems thinking and government policy" - SRBVS, 14(6), 1997
- KEINY, Shoshana: "Learning as knowledge construction within a community of learners (D. SCHÖN)"- C&HK, 7(2-3) 2000
- KELLER, F.E.: "Refiguring life: metaphors of 20th Century biology" - Columbia Univ. Press, New York, 1995
- KELLER, Kurt D.: "Sociotechnics and the structuring of meaning"- C&HK, 6(2), 1999
- KELLY, C.A.: "The psychology of personal constructs"- Norton, New York, 1955
- KELLY, K.: "Out of control: the new biology of machines, social systems and the economic world"- Addison Wesley, Reading, Mass., 1994
- KELLY, K.: "The rise of neo-biological civilization" - Addison Wesley, Menlo Park, CA., 1995
- KELSO, J.A.S.: "Dynamic patterns: the self-organization of brain and behavior" - MIT Press, Cambridge, MA., 1999
- KEMPF, Hervé: "L'Ecosystème" - La Recherche, Nr. 308, April 1998
- KERN, S.: "The culture of time and space 1880-1918" - Harvard Univ. Press, Cambridge, MA, 1983
- KETNER, Kenneth Laine: "Peirce and Turing: comparisons and conjectures" - Semiotica, 68, 1988
- KEYS, Paul: "Operational research and systems: the systemic nature of operational research"- Plenum, N.Y., 1991
- KEYS, Paul (ed.): "Understanding the process of operational research: collected readings"- Wiley, Chichester, 1995
- KEYS, Paul: "Creativity, Design and Style in Management Science/Operational Research", Research Memorandum, Nr.18, - University of Hull, 1998
- KHAKHINA, L.N.: "Concepts of Symbiogenesis" (in Russian) - Akademie NAUK, Leningrad, URSS, 1979
- KHAKHINA, L.N.: "Evolutionary Significance of Symbiosis: Development of the Symbiogenesis Concept" - Symbiosis, Vol. 14, p.217-28, 1992
- KHISTY, C.J. & ZEITLER, U.: "Hypermobility: a challenge for transports ethics and systemicity"- SPAR, 14(5) 2001
- KHURI, Richard K.: "Prime matter: its unlimited ...and their bearing on emergence and evolution" - CASYS J., 2, Inst. of Math., Univ. of Liège, Belgium, 1998
- KICK, R. & SWANSON, G.A.: "A world on edge: is a new supranational system propelling the world toward socio-economic chaos"- Proceed. 42nd ISSS Meet., Atlanta, 1997
- KIEL, L.: "The nonlinear paradigm: advancing paradigmatic progress in the policy sciences". Syst. Research, 9 (2) 1992
- KIEL, L.D. & ELLIOT, E.: "Chaos theory in the social sciences: foundations and applications". Univ. Michigan Press, Ann Arbor, 1997
- KILE, Frederick: "Toward quantification of conscious intelligent processes in at least some cybernetic systems". ASC Cyb. Forum, 7 (1) 1975
- KILE, F. & RABEHL, A.: "The agenda of the modeler". ASC Cyb. Forum, 9 (1/2) 1979
- KIM KEUNG HO, Joseph: "Multi perspective systems based frameworks and decision support systems studies"- SRBVS, 14(4), 1997
- KIMBLE D.P. (ed): "The anatomy of memory". Science and Behav. Books, Palo Alto, 1965
- KIRKEBY, Ole Fogh: "Event and body-mind; an outline of a post-postmodern approach to phenomenology"- C&HK 4(2/3) 1997
- KIRSCHNER, M. & HUTCHINSON, T.: "Beyond self-assembly: from microtubules to morphogenesis". Cell, 45, 1986
- KIRVELIS, Dobilas: "Analog neural networks: non-linear feedback"- CASYS J., 7, Liège, Belgium, 2000
- KLABBERS, J.H.G. "Appearing knowledge for policy formation: some bottle-necks" in G. de Zeeuw (ed.) "Knowledge (dis) appearance" Systeem Groep Nederland, Delft University Press, 1986
- KLAPP, O.E.: "Opening and closing in open systems". Behav. Science, 20 (4), 1975
- KLARREICH, Erica: "Playing both sides" - The Sciences, 41(1), p. 25-29, Jan.-feb. 2001
- KLAUS, Georg: "Kybernetik und Gesellschaft". Dietz Verlag, Berlin, 1964
- KLAUS, Georg: "Kybernetik in philosophischer Sicht". Dietz Verlag, Berlin, 1965
- KLAUS, Georg: "Kybernetik und Erkenntnis Theorie". Dietz Verlag, Berlin, 1972
- KLAUS, Georg & LIEBSCHER, Heinz: "Wörterbuch der Kybernetik". Dietz Verlag, Berlin, 1976
- KLEIN, G.A.: "Sources of power: how people make decisions"- MIT Press, London, 1998
- KLEIN, H.K. & KUMAR, K. (Eds.): "Information Systems development for human progress in organizations" - North Holland, Amsterdam, 1989
- KLEIN, Naomi: "No Logo" - Flamingo, Harper Collins, London, 2001
- KLIMEK, R.: "Introduction to temporal logic" - AGH. Univ. Press, Krakow, 1999 (in Polish)
- KLIMEK, R.: "A method of a systematic system analysis using temporal logic"- Proc. 15th Cyb. & Syst. Meet., Austrian Soc. Cyb. Studies, Vienna, 2000
- KLINE, Morris: "Mathematics: The loss of certainty". Oxford Univ. Press, New York, 1980 (See also Lolli, G.)
- KLINE, Stephan Jay: "Conceptual Foundations for Multidisciplinary Thinking" - Stanford Univ. Press, 1995
- KLINGER, Allen: "Human-machine interactive systems" - Plenum Publ., New York, 1991
- KLIR, George: "The G.S. Theory as methodological tool". SGSR Yearbook, X, 1965
- KLIR, George: "Processing of general system activity". SGSR Yearbook, XII, 1967
- KLIR, George: "An approach to General Systems Theory". Van Nostrand Reinhold, New York, 1969
- KLIR, George: "Trends in General Systems Theory". Wiley, New York, 1972
- KLIR, George: "On the representation of activity arrays". Intern. J. Gen. Systems, 2 (3) 1975
- KLIR, G. & ROGERS, G. (eds): "Basic and applied General Systems Research: a bibliography". State Univ. of New York, Binghamton, 1977
- KLIR, George: "Identification of generative structures in empirical data". Intern. J. Gen. Systems, 3 (3) 1977
- KLIR, George (ed): "Applied systems research". Plenum Press, New York, 1978

- KLIR, G. & UYTENHOVE, H.J.: "Procedures for generating reconstruction hypotheses in the reconstructability analysis". *Intern. J. Gen. Systems*, 5 (4) 1979
- KLIR, George (ed): "Reconstructability analysis". A special issue of *Intern. J. of Gen. Systems*, 7 (1), 1981
- KLIR, George: "Architecture of System Problems Solving". Plenum Press, New York, 1985
- KLIR, George: "Complexity: Some general observations". *Syst. Research*, 2 (2), 1985
- KLIR, George: "The emergence of two-dimensional science in the information society". *Syst. Research* 2 (1), 1985
- KLIR, George: "Reconstructability analysis: an offspring of Ashby's constraint analysis". *Syst. Research*, 3 (4) 1986
- KLIR, G. & FOLGER, Tina A.: "Fuzzy sets, uncertainty and information". Prentice Hall, Englewood Cliffs, NJ, 1988
- KLIR, George: "Systems profile: the emergence of systems science". *Syst. Research*, 5 (2) 1988
- KLIR, George: "A principle of uncertainty invariance". *Intern. J. of Approx. Reasoning*, 16, 1990
- KLIR, George: "Dynamic aspects in reconstructability analysis: the role of minimum uncertainty principles". *Rev. Intern. de Systémique*, 4 (1) 1990
- KLIR, George: "Reconstruction principle of inductive reasoning". *Rev. Intern. de Systémique*, 4 (1) 1990
- KLIR, George (ed): "Facets of Systems Science". Plenum Press, New York, 1991 (contains an important bibliography)
- KLIR, George: "Systems Science: a guided tour". *J. Biol. Syst.* 1 (1) 1993
- KLOPF, A. Harry: "Brain function and adaptive systems; a heterostatic theory". Air Force Systems Command. U.S.A.F. Special Report nr. 133, March 3, 1972
- KLOPF, A.H.: "The hedonistic neuron: a theory of memory, learning and intelligence". Hemisphere, New York, 1980
- KNOR CETINA, K.: "Epistemic cultures; how the sciences make knowledge". Harvard Univ. Press, Cambridge, MA, 1999
- KNYAZEVA, Helena N. & KURDYUMOV, S.P.: "Evolution and Self-organization Laws in Complex Systems" - (in russian) - Nauka, Moscow, 1994
- KNYAZEVA, Helena: "What is Synergetics" - (pers. communication) - 1998
- KNYAZEVA, Helena N. & KURDYUMOV, S.P.: "Foundations of synergetics: blow-up regimes, self-organization, tempoworlds" (in russian). Aletheia, Sankt Petersburg, 2002
- KNYAZEVA, Helena N.: "Self-reflective synergetics" - *SRBVS*, 20(1), 2003
- KOCH, C.: "Biophysics of Computation" - Oxford Univ. Press, New York, 1999
- KOCH, Christof & LAURENT, Gilles: "Complexity and the Nervous System" - *Science*, Vol.284, Nr.5411, p. 98-8, April 2, 1999
- KOCH, W.A.: "Evolutionäre Kultursemiotik" - Bochum, 1986
- KOCHEN, Manfred: "Organized systems with discrete information transfer". *SGSR Yearbook* 2, 1957
- KOCKLEMANS, Joseph: "Interdisciplinarity and Higher education" - Pennsylvania State University Press, 1979
- KOESTLER, Arthur: "The act of Creation". Pan Books, London, 1966
- KOESTLER, Arthur: "The ghost in the machine" - Hutchinson, London, 1967
- KOESTLER, Arthur & SMYTHIES, J.R. (eds): "Beyond Reductionism". Hutchinson, London, 1969
- KOESTLER, Arthur: "Der Mensch" - Irrläufer der Evolution" - Bern/München, 1978
- KOESTLER, Arthur: "Janus, a summing up" - Hutchinson & Co., London, 1978
- KÖVECSÉS, Z.: "Emotion concepts" - Springer, New York, 1990
- KOFFKA, K.: "Principles of Gestalt Psychology". Harcourt, Brace, New York, 1935
- KÖHLER, W.: "Gestalt Psychology". H. Liveright, New York, 1929
- KÖHLER, W.: "Closed and Open Systems", in Emery, F.E.(ed.) "Systems Thinking". Penguin, Harmondsworth, 1969
- KOHONEN, T.: "Self-organization and associative memory" - Springer, Heidelberg, 1984
- KOHONEN, T.: "Self-organizing maps" - Springer, Berlin, 1997
- KOHOUT, L. & GAINES, B.: "Protection as a general systems problem". *Intern. J. Gen. Systems*, 3 (1) 1976
- KOIZUMI, T.: "Coordination social and technological development", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- KOIZUMI, Tetsunori: "Social cybernetics: promises and pitfalls" - *Cybernetica XXXVII*, (3/4), 1994
- KOIZUMI, Tetsunori: "Ecology, economics, ethics: mending the broken circle" - *Advances in sociocybernetics* - IAS, Windsor, Canada, 1995
- KOIZUMI, Tetsunori: "Nature, spirituality, and environmental ethics: east meets west" - *C&HK* 4(4) 1997
- KOIZUMI, Tetsunori & LUNDSTEDT, S.B.: "Mind culture and economy: the morphology of socio-economic systems" - *Cybernetica*, XLI, (2-4), 1998
- KONDRATIEFF, N.D.: "The long waves in economic life". *Lloyds Bank Rev.*, nr. 129, 1978 (A translation of Kondratieff's original article "Die Langen Wellen der Konjunktur". *Archiv f. Sozialwissenschaft und Sozialpolitik*, V. 56, nr.3, 1926)
- KONIG, D.: "Theorie der endlichen und unendlichen Graphen" - Leipzig, 1936
- KONIGSWIESER, R. & LUTZ, C. (eds.): "Das systemisch evolutionary Management" - CRAC, Vienna, 1992
- KOOISTRA, J.: "Denken is bedacht" (in Dutch) - Giordano Bruno, Culemborg, Netherlands, 1988
- KOOISTRA, J.: "Speeding-up knowledge" - *Systemica*, 9, 1993
- KOOISTRA, J.: "Flowing (about means and outcomes in social practices)" - *SRBVS*, 19(2)1999
- KORN, J.: "Emergence and the evolution of complexity" - *Gen. Syst. Bull.*, 32, 2003
- KORNWACHS, Klaus(ed.): "Offenheit-Zeitlichkeit-Komplexität: zur Theorie der Offene Systeme" - Campus, Frankfurt a/M, 1984
- KORNWACHS, K. & von LUCADOU, W.: "Open systems and complexity", in G.L. Dalenoort (ed): "The Paradigm of self-organization". Gordon & Breach, New York, 1989
- KORNWACHS, K. & JACOBY, K.: "Information: new questions to a multidisciplinary concept" - Akademie Verlag, Berlin, 1996
- KORZYBSKI, Alfred: "Science and Sanity". 5th ed. Institute of General Semantics, Chicago, 1994 (1st edit, 1933)
- KORZYBSKI, Alfred: "Manhood of Humanity". The International Non-Aristotelian Library Publ. Co., Lakeville, Conn., 1950
- KOSSLYN, S.M. & KOENIG, O.: "Wet mind: the new cognitive neuroscience" - Oxford Univ. Press, New York, 1995
- KOSTITZYN, A.: "Biologie mathématique". A. Colin, Paris, 1937
- KOTARBINSKI, Tadeus: "Praxiology. An introduction to the Sciences of Efficient Action" - Pergamon Press, London, 1965
- KOTARBINSKI, T.: "Concepts and problems in general methodology and methodology of the practical sciences", in Przelecki, R. & Wjicki, R.(eds): "25 Years of logical methodology in Poland". Warszawa-Dordrecht, PWN, Reidel, 1989
- KOTARBINSKI, Tadeus: "The Methodology of Practical Skills: Concepts and Issues", in COLLEN, A. & GASPARSKI, Wojciech (Eds): "Design and Systems: General Applications of Methodology" ("Praxiology" Vol. 3) - Transactions Publishers, New Brunswick (U.S.A.) or London, 1995
- KOUTROUFINIS, Spyridon A.: "Selbstorganisation ohne Selbst: Irrtümer gegenwärtiger evolutionärer Systemtheorien" - Pharus Verlag, Berlin, 1996
- KOZO-POLYANSKY, B.M.: "A new Principle of Biology: Essay on the Theory of Symbiogenesis" (in Russian) - Moscow (quoted by KHAKHINA, L.N.)
- KRÄMER, Sybille: "Symbolische Maschinen" - Wiss. Buchgesellschaft, Darmstadt, 1988
- KRAMPE, M.: "Phytosemiotics" - *Semiotica*, 36, 1981
- KRATTLI, Inga: "Territoriality and social organization: man's spatial relationships" - *Proc. 42nd. ISSS Conf.*, Atlanta, 1998
- KRAWIETZ, W. & WELKER, M. (eds.): "Kritik der Theorie sozialer Systeme" Suhrkamp, Frankfurt a/M, 1992
- KREMYANSKIY, V.I.: "Certain peculiarities of organisms as a "System" from the point of view of Physics, Cybernetics and Biology", in Emery, F.E.(ed): "Systems Thinking". Penguin, Harmondsworth, 1969. Also in *SGSR Yearbook*, 5, 1960
- KREWERAS, Germain: "Graphes et chaines de Markov". Dalloz, Paris, 1972
- KRIEGER, M., BILLETER, J.B. & KELLER, L.: "Antlike task allocation and recruitment in cooperative robots" - *Nature*, 406 (6799), August 31st, 2000
- KRIPPENDORF, Klaus (ed.): "Communication and control in society" - Gordon & Breach, New York, 1979
- KRIPPENDORF, Klaus: "Major metaphors on communication and some constructivist reflections on their use" - *C&HK*, 29(1), 1993
- KRIPPENDORF, Klaus: "A recursive theory of communication" - In D. Crowley and D. Mitchell (eds.): *Communication theory today* - Stanford Univ. Press, Stanford, CA., 1994
- KRIPPENDORF, Klaus: "The construction of social reality" by John Searle; a review - *C&HK*, 3 (4), 1996
- KRIPPENDORFF, Klaus: "Communication and the genesis of structure". *SGSR Yearbook*, 16, 1971

- KRIPPENDORFF, Klaus: "A dictionary of cybernetics". Univ. of Pennsylvania, 1986
- KRIPPNER, S. et al.: "Toward the Application of General Systems Theory in Humanistic Psychology" - *Systems Research*, 2 (2), 1985
- KRIPPNER, S. & COMBS, A.: "A systems approach to studies of creativity and consciousness" - *SRBVS*, 15(2) 1998
- KROHN, W., KUPPERS, G. & NOWOTNY, H.(eds.): "Self organization: portrait of a scientific revolution" - Kluwer, Dordrecht, 1990
- KROOG, G.von & ROOS, J.: "Organizational epistemology" - Macmillan, London, 1995
- KROWITZ, Edward J.: "Economic development, cognitive dissonance and the theory of change". *Syst. Research*, 9 (1) 1991
- KRYSMANSKI, H.J.: "Soziologie des Konflikts" - Rowohlt, Hamburg, 1971
- KUBAT, L. & ZEMAN, J.: "Entropy and information in science and philosophy" - The Free Press, New York, 1975
- KUBAT, Miroslav: "A machine-learning based approach to load balancing in computer networks". *Cyb. & Systems*, Vol.23 (3/4) 1992
- KUBE, C.R. & ZHANG, H.: "Collective Robotics: From social insects to robots" - *Adaptive Behavior*, 2, 1994
- KUHN, Alfred: "The logic of social systems". Jossey Bass, San Francisco, 1974
- KUHN, Alfred: "Unified social sciences: A system-based introduction". Dorsey Press, Homewood, IL, 1975
- KUHN, A.: "Differences vs. similarities in Living Systems" - *Behav. Sci.*, 25, 1980, p. 40-45
- KUHN, Hans: "Model consideration of the origin of life: Environmental structure as stimulus for the evolution of chemical systems". *Naturwissenschaften*, 63, (2) 1976
- KUHN, Lesley: "Complexity, cybernetics and human knowing" - *C&HK*, 9(1) 2002
- KULL, Kalevi: "Organism as a self-reading text: anticipation and semiosis". - *CASYS J.*, 2, Inst. of Mathematics, Univ. of Liège, Belgium, 1998
- KUHN, Thomas: "The structure of Scientific revolutions". (2ed.) Univ. of Chicago Press, Chicago, 1970
- KULL, Kalevi (ed.): "The logical and semiotic status of Jakob von Uexküll's concept of Umwelt - Semiotica, special issue, 2000
- KULL, Kalevi: "Organisms can be proud to have been their own designers" - *C&HK*, 7(1) 2000
- KULL, Kalevi: "Living forms are communicative structures based on the organic codes" - *C&HK*, 8(3) 2001
- KULLENBERG, B.: "Chemical communication between chemical organisms". *Endeavour*, May 1975
- KURZWEIL, R.: "The age of intelligent machines" - Viking, New York, 1999
- KYOUNG WON LEE: "A study of the breakdown of the state socialist system: a systems approach" - *SRBVS*, 14(6) 1997
- LABINGER, A. & COLLINS, H. (eds.): "The One culture? A conversation about science" - Univ. of Chicago Press, 2000
- LABORIT, Henri: "Résistance et soumission en physio-biologie" Masson, Paris, 1954
- LABORIT, Henri: "L'agressivité détournée". U.G.E. Paris, 1970
- LABORIT, Henri: "L'illogique de l'événement". Communications nr. 18, Le Seuil, Paris, 1972
- LABORIT, H.: "Les comportements: biologie, physiologie, pharmacologie" - Masson, Paris, 1973
- LABORIT, Henri: "Eloge de la fuite". Laffont, Paris, 1976
- LADD HOLLIST, W. & ROSENAU, James (Eds): "World system structure" - Sage, Beverly Hills, 1985
- LAKOFF, G. & JOHNSON, M.: "Philosophy in the flesh: the embodied mind and its challenge to western thought" - Basic Books, New York, 1999
- LAMBERT, Philippe: "Les Chemins du stress" - Athena Nr. 139, Liège, Belgium, mars 1998
- LAMBERT, Philippe: "Neuropsychologie cognitive: Le Cerveau "pluriel" - Athena Nr.153, Liège, Belgium, septembre 1999
- LANDA, Lev N.: "Instructional regulation and control: cybernetics, algorithmization and heuristics in education". Educ. Techn. Publications, Englewood Cliffs, N.J., 1976. (Spanish translation used)
- LANDA, P.S.: "Nonlinear oscillations and waves in dynamical systems" - Kluwer, Dordrecht, 1996
- LANDA, P.S.: "Strong influence of small fluctuations in nonlinear systems" - *CASYS J.*, 5, Univ. Liège, 2000
- LANDES, D.S.: "Revolution in time" - Harvard Univ. Press, Cambridge, MA, 1983
- LANDESMAN, Charles: "An introduction to epistemology" - Blackwell Publ., Cambridge, MA., 1997
- LANE, David C. & JACKSON, M.C.: "Only connect! An annotated bibliography reflecting the breadth and diversity of Systems Thinking". *Syst. Research*, 12 (3) 1995
- LANE, D.: "Should systems dynamics be described as a "hard" or "deterministic" systems approach" - *Syst. Research*, 17(3) 2000
- LANGDON-LANE, J.S. & QUINN, J.A.: "Growth and ergodicity: has the world converged?" - Univ. of New South Wales, Sydney, 2000
- LANGE, Oskar: "Wholes and parts: a general theory of system behavior". Pergamon Press, New York, 1965
- LANGER, Suzanne: "Philosophy in a new key". Mentor Books, New York, 1948
- LANGTON, Chris: "Self-reproduction in cellular automata". *Physica* 10D, 1984
- LANGTON, Chris: "Studying Artificial Life with Cellular Automata". *Physica* 22D, 1986
- LANGTON, Chris (ed.): "Artificial life". Santa Fe Institute Studies in the Sciences of Complexity. Addison Wesley, Reading, Mass., 1989
- LANGTON, Christopher G. et al: "Artificial Life II" - Santa Fe Institute Studies in the Sciences of Complexity, Proceedings, Vol.10, Redwood City, CA., 1992
- LANGTON, Christopher G.: "Artificial Life: An Overview" - The M.I.T. Press, Cambridge, Mass, 1995
- LAPIERRE, Jean W.: "L'analyse des systèmes politiques". PUF, Paris, 1974
- LAPIERRE, Jean William: "L'analyse de systèmes. Application aux sciences sociales" - Syros, Paris, 1992
- LAPP, Ralph: "The logarithmic Century". Prentice Hall, Englewood Cliffs, 1973
- LAROCHELLE, M. et al.(eds.): "Constructivism and education" - Cambridge Univ. Press, New York, 1998
- LARSSON, Mils O.: "A design view on research in social sciences" - *SPAR*, 14(4) 2001
- LASKAR, J. & FROESCHLE, C.: "Le Chaos dans le système solaire". *La Recherche* n° 232, mai 1991
- LASKER, George (ed): "Applied systems and cybernetics". Pergamon, London, 1981
- LASKER, George (ed): "Advances in Systems Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- LASZLO, Alexander: "A cognitive map of cultural change", in B. Banathy & R. Rodriguez Delgado (eds): "Intern Syst. Science Handbook". Systemic Publ., Madrid, 1993
- LASZLO, Alexander: "The epistemological foundations of evolutionary systems design" - *SRBVS*, 18(5), 2001
- LASZLO, Erwin: "Systems, structure and experience". Gordon & Breach, New York, 1969
- LASZLO, Erwin: "Introduction to systems philosophy: Toward a new paradigm of contemporary thought". Gordon & Breach, New York, 1972
- LASZLO, Erwin (ed): "The relevance of General System Theory". Braziller, New York, 1972
- LASZLO, Erwin: "The systems view of the world". Gordon & Breach, New York, 1972
- LASZLO, Erwin (ed): "The world system: Models, norms, variations". Braziller, New York, 1973
- LASZLO, Erwin: "A strategy for the future". Braziller, New York, 1974
- LASZLO, Erwin: "Cybernetics in an evolving social system". *Kybernetes* 13, 1984
- LASZLO, Erwin: "Evolution: The grand Synthesis". Shambala, Boston, 1987
- LASZLO, Erwin: "La cohérence du réel" - Gauthier Villars, Paris, 1989
- LASZLO, Erwin: "Sociocultural systems: the cognitive dimension of cultural change" - In *Rev. Internac. de Sistemas*, 2 (1) 1990
- LASZLO, Erwin: "The age of bifurcation: Understanding the changing world" - Gordon & Breach, Philadelphia, 1991
- LASZLO, Erwin (ed): "The new evolutionary paradigm". Gordon & Breach, New York, 1991
- LASZLO, Erwin: "Aux racines de l'univers. Vers l'unification de la connaissance scientifique" - Fayard, Paris, 1992
- LASZLO, Erwin: "Information technology and social change". *Behav. Science*, 37 (4) 1992
- LASZLO, Erwin: "Main currents in systems thinking: GST and general evolution theory", in B. Banathy & R. Rodriguez Delgado (eds.): "Intern. Syst. Sc. Handbook". Systemic Publ. Madrid, 1993
- LASZLO, Erwin: "The creative cosmos: a unified science of matter, life and mind" - Floris Books, England, 1993
- LASZLO, E., MASULLI, I. et al. (eds.): "The evolution of cognitive maps: New paradigms for the 21st Century" - Gordon & Breach, New York, 1993
- LASZLO, Erwin: "Psy-field memory: the missing factor in the emergence of order" - *C&HK*, 2 (3) 1994
- LASZLO, Erwin: "The choice: evolution or extinction" - Tarcher/ Putnam, New York, 1994
- LASZLO, Erwin: "The interconnected universe: conceptual foundations of transdisciplinary unified theory" - World Scientific, Singapore, 1995

- LASZLO, Erwin: "Evolutionary systems design: Way beyond the two cultures". In ROWLAND, G. (Ed.): *Proceedings of the 8th. International Conversation on comprehensive design of social systems* - ISI, Carmel, CA, 1996
- LASZLO, Erwin: "Evolution: the general theory" - Hampton Press, New Jersey, 1996
- LASZLO, Erwin: "The whispering pond" - Element Books, Australia, 1996
- LASZLO, Erwin: "Planetary consciousness: our next evolutionary step: The Club of Budapest" - C&HK, 4(4), 1997
- LASZLO, Erwin: "Holos: die Welt der neuen Wissenschaften" - Via Nova, Petersburg, 2002
- LASZLO, K., LASZLO, A. et al.: "Building a design culture through evolutionary learning communities" - *Proceedings of the 7th International Conversations on the Comprehensive design of social systems*, ISI, Pacific Grove, 1995
- LAURILLARD, Diana: "A Conversational Framework for Individual Learning applied to the Learning Organization" and the "Learning Society" - *SRBVS*, 16, (2), 1999
- LAVIGNE, F. & LAVIGNE, P.: "Anticipatory semantic process" - *CASYS J. 7*, Inst. de Math., Univ. de Liège, 2000
- LAVILLE, Charles: "Mécanismes biologiques de l'atome à l'être vivant". Dunod, Paris, 1950
- LAVILLE, Chester A.: "Language, Communication and biological organization". *SGSR Yearbook*, VIII, 1963
- LAW, J.(ed.) : "A sociology of monsters: essays on power, technology and domination" - Routledge, London, 1991
- LAWER, E.(ed.): "Advances in group processes" - Jai Press, Greenwich, CT., 1987
- LEACH, Edmund: "Culture and communication: the logic by which symbols are connected" - Cambridge Univ. Press, 1976
- LE BON, Gustave: "Psychologie des foules". Alcan, Paris, 1895 English translation: "The crowd". Viking Press, New York, 1960
- LECOMTE DU NOUY, Pierre: "Le temps et la vie". Gallimard, Paris, 1936
- LEDINGTON, Paul: "Relevance, formality and process: Toward a theory of soft systems practice". *Syst. Research*, 9 (4) 1992
- LEDINGTON, Paul W. & LEDINGTON, J.: "The Problem of Comparison in Soft Systems Methodology" - *SRBVS*, Vol.16, Nr.4, 1999
- LEDOUX, J.E.: "Emotion, memory and the brain" - *Sc.Amer.*, June 1994
- LEDOUX, J.E.: "The emotional brain" - Simon & Schuster, New York, 1996
- LE DUC, Michael: "Elements of constructivist systems". *Proc. 36th. ISSS Meeting*, Denver, 1992
- LEE, Beomung: "Communitarian ethics and system thinking to build the sustainable ecological community" - 42nd ISSS Conf., Atlanta, 1998
- LEEJW, S.E. van der: "Archeological approach to the study of complexity". - University of Amsterdam, 1981
- LEFEVER, René: "Stabilité globale et mécanismes de fluctuations des structures dissipatives". *J. de Physique*, 38 (8) 1978
- LEFEVER, René: "Progrès en thermodynamique de non-équilibre". *Encycl. Universalis*, Paris, 1979
- LEFEVER, R & PRIGOGINE, I.: "Immune systems and stability: a case study of non-equilibrium phase transition in biology". *Service Chimie Physique II*, Univ. Libre de Bruxelles, Brussels, 1986
- LEFF, H.S. & REX, A.(eds.): "Maxwell's demon, entropy, information, computation" - Adam Hilger, Bristol, 1990
- LEHNINGER, Albert L.: "Bioenergetics: The molecular basis of biological energy transformations". W. Benjamin, New York, 1965
- LEHTINEN, E. & LYYTINEN, K.: "Discourses analysis as an information system specification method" - in "Proceedings of the 7th Scandinavian Research Seminar on Systemeering", Helsinki, 1984
- LEHTINEN, E. & LYYTINEN, K.: "Action based model of information systems" - *Journ. of Information Systems*, 3, 1993
- LEIBNIZ, G.W.: "Discourse on metaphysics and the monadology" (orig. German 1714) - Prometheus Books, New York
- LEIGH, E.: "Genes, Bees and Ecosystems: The Evolution of a Common Interest among Individuals" - *Tree*, Vol.6, Nr.8, p. 257-62, 1991
- LEKTORSKY, V.A.: "Subject, object, cognition" (in russian)- *Nauka*, Moscow, 1980
- LEMIRE, Gilles: "La nouvelle éducation et sa dimension transdisciplinaire" - from <http://www.ciret>
- LE MOIGNE, J.L.: "La théorie du Système Général: théorie de la modélisation". P.U.F., Paris, 1977
- LE MOIGNE, J.L.: "De la systémique molle à la systémique douce". *Rev. Intern. de Systémique*, 3 (2), 1989
- LE MOIGNE, J.L.: "Quelle épistémologie pour une science des systèmes naturels?". *Rev. Intern. de Systémique*, 3 (3) 1989
- LE MOIGNE, J.L.: "La modélisation des systèmes complexes". Dunod, Paris, 1990a
- LE MOIGNE, Jean-Louis: "Les épistémologies constructivistes"- *Que sais-je?* Presses Univ. de France, Paris, 1995
- LE MOIGNE, J.L.: "Conception de la complexité et complexité de la conception". *Rev. Intern. de Systémique*, 4 (2) 1990b
- LE MOIGNE, J.L.: "Le Constructivisme - Vol.1: Des Fondements; Vol.2: Des Epistémologies" - E.S.F., Paris, 1995
- LENK, H.: "Zur Sozialphilosophie der Technik"- Suhrkamp, Frankfurt a/M., 1982
- LEONTIEFF, W.: "Input-output economics" - Oxford University Press, New York, 1966
- LEPEE, P.: "Rapport entre connaissance et action" - *Rev. Internat. Systémique*, 11(3)1997
- LE PEUTREC, S. & COURANT, M.: "Autonomy and knowledge organization". *World Scientific*, Singapore, 1994
- LEPINARD, D.: "Analyse des composantes des mouvements de l'évolution". *Cybernetica*, XXXVI (1) 1993
- LEPLATRE, G. & BREWSTER, S.A.: "Perspectives on the design of musical auditory interfaces"- *CASYS J.*, 4, Inst.de Mathem., Univ. de Liège, Belgium, 1999
- LEPLIN, J. (ed.): "Scientific realism" - Univ. of California Press, Berkeley, CA., 1984
- LERDAHL, F. & JACKENDORFF, R.: "A generative theory of tonal music" - MIT Press, 1983
- LERNER, A.Ya: "Fundamentals of Cybernetics". Chapman & Hall, London, 1972
- LERNER, Daniel: "Parts and wholes". Free Press, Glencoe, 1963
- LERNER, V.S.: "Information systems theory: concepts, history and applications"- *J. Syst.Anal.Model. Simul.*, 35, 1999
- LERNER, V.S.: "Information functional mechanism of cyclic functioning" - *J.Biol.Syst.*, 9(3) 2001
- LERNER, V.S.: "Information macrodynamics for cognitive information modeling and computation" - *J.Intell. Syst.*9(3) 2001
- LERNER, V.S.: "Information systems modeling" - *Gen. Syst. Bulletin*, 32, 2003
- LEROY, Alain & SIGNORET, Jean-Pierre: "Le risque technologique" - *Que Sais-je*, Nr.2669, Presses Univ. de France, Paris, 1992
- LESIEUR, Marcel: "La turbulence développée". *La Recherche*, Nr.139, Dec. 1982
- LESOURNE, Jacques: "Les systèmes du destin". Dalloz, Paris, 1976
- LESOURNE, Jacques: "La notion de système et les sciences sociales". *Futuribles*, nr.23, Paris, 1979
- LETTVIN, J.Y. et al.: "What the frog's eye tells to the frog's brain". *Proc. of the Inst. of Radio Eng.*, p.1940, 1959
- LEVCHENKO, Vladimir: "Ecological crisis as evolutionary events canalised by the biosphere - *CASYS J.*, 3, Inst. Mathem., University of Liège, Belgium, 1998
- LEVIN, D.M.: "The body's recollection of being" - Routledge & Kegan Paul, Boston, 1985
- LEVIN, M. & KNUTSTAD, G.: "Construction of learning networks"- *SPAR*, 16(1) 2003
- LEVINAS, E.: "The Levinas reader" - Basil Blackwell, Cambridge, 1989
- LEVINE, D.S. & LEVEN, S.J. (eds.): "Motivation, emotion and goal direction in neural networks" - L. Erlbaum Assoc., Hillsdale, N.J., 1992
- LEVINE, D.S. & APARICIO, V.M. (eds.): "Neural networks for knowledge, representation and inference"- Lawrence Erlbaum, Hillsdale, NJ., 1994
- LEVINS, Richard: "Mendelian species as adaptive systems". *SGSR. Yearbook*, 6, 1961
- LEVINS, R.: "Evolution in Changing Environments" - Princeton Univ. Press, 1968
- LEVINS, R.: "Dialectics and System Theory"- *Science and society*, 63(3) 1998a
- LEVINS, R.: "The internal and external in explanatory theories"- *Science and culture*, 7(4) 1998b
- LEVINSON, Paul: "The soft edge: a natural history and future of the information revolution" - Routledge, London, 1997
- LEVI-STRAUSS, C.: "Structures élémentaires de la parenté"- Presses Univ. de France, Paris, 1949
- LEVI-STRAUSS, C.: "Structural anthropology" - Doubleday, New York, 1967
- LEVKOV, S. & MAKARENKO, A.: "Neuronet approach to modeling of large social: ecological and economical systems"- *Proc. 42nd ISSS Conf.*, Atlanta, 1998
- LEVY, Steven: "Artificial Life: The Quest for a new Creation" - Vintage Books, New York, 1992
- LEWIN, K.: "Group decisions and social change" . In T.M NEWCOMB & E.L. HARTLEY (eds.) "Readings in social psychology" - H. Holt, New York, 1947

- LEWIN, Kurt: "Frontiers in group dynamics". Human Relations 1947, (p.5-41)
- LEWIN, Kurt: "Field theory in social sciences". Harper & Row, New York, 1951
- LEWIN, Roger: "Complexity: Life at the edge of chaos". Collier Books, Macmillan, New York, 1992
- LEWIN, Roger: "An orderly progression out of chaos". New Scientist, 138 (1876) Jun.5, 1993
- LEWIN, Roger: "A simple matter of complexity". New Scientist, 141 (Nr. 1911) Feb.5, 1994
- LEWIN, Roger: "It is a jungle out there" - N.Sc., November 29th, 1997
- LEWIN, Roger: "Ruling Passions" - N.Sc., nr. 2199, April 3rd, 1999
- LEWIS, G. J. & STEWART, N.: "The measurement of environmental performance: an application of Ashby's law" - SRBVS, 20(1) 2003
- LEWIS, P.: "Kondratieff's long waves in economic life". Lloyds Bank Rev., nr. 131, 1979
- LEWIS, Paul: "Information- systems development" - Pitman, London, 1994
- LEWONTIN, Richard C.: "The meaning of stability". Brookhaven Symp. on Biology, 22, (p.13-24), 1969
- LEWONTIN, Richard C.: "The organism as the subject and object of evolution". Scientia, 118 (I-VIII), Milano, 1983
- LEYDESORFF, Loet: "Luhmann, Habermas and the theory of communication" - SRBVS, 17 (3), 2000
- LEYDESORFF, Loet: "The communication turn in the theory of social systems" - SRBVS, 19(2) 2002
- LEYTON, Michael: "Inferring causal history from shape", in G. Lasker (ed): "Advances in Systems Research and Cybernetics" Univ. of Windsor, Ontario, Canada, 1988
- LI, T. & YORKE, J.A.: "Period three implies chaos". Amer. Math. Monthly, 82, 1975
- LIAPUNOV, A.M.: "Stability of motion". Academic Press, New York, 1966 (Original in Russian: Khar'kov, 1892)
- LICHNEROWICZ, A. et al.: "Structure et dynamique des Systèmes". Maloine Doin, Paris, 1976
- LICHNEROWICZ, A. et al.: "L'idée de regulation dans les sciences". Maloine Doin, Paris, 1977
- LIEBERMAN, Philip: "Peak Capacity" - The Sciences, V.37 (6), 1997
- LIEBERMAN, Philip: "Eve spoke" - (On the genesis of language) - Picador-Macmillan, London, New York, 1998
- LILIENTHAL, Robert: "The rise of systems Theory: an ideological analysis". Wiley Interscience, New York, 1978
- LILIENTHAL, Robert: "Notes on the crisis of cybernetics". ASC Cyb. Forum, 9 (4) 1979
- LIN, Yi: "General systems Theory: A mathematical approach" - Kluwer Academic/Plenum, New York, 1999
- LIND, Jürgen: "A development method for multiagent systems" - 15th Cyb. & Syst. Meet., Austrian Soc. for Cyb. Studies, Vienna, 2000
- LINDEMAYER, A. & CULIK, K.II: "Growing cellular systems: generation of graphs by parallel rewriting". Intern. J. Gen. Systems, 5 (1) 1979
- LINDENBERG, K. & WEST, B.J.: "The nonequilibrium statistical mechanics of open and closed systems" - VCH Publ., New York, 1990
- LINSTONE, Harold (Ed.): "Multiple perspectives for decision-making" - North Holland, New York, 1984
- LINSTONE, Harold: "Multiple perspectives: concept, applications and user guidelines". Syst. Pract., 2 (3) 1989
- LINSTONE, H. & MITROFF, I.I.: "The challenge of the 21st century: Managing technology and ourselves in a shrinking world" - State University of New York Press, 1994 (with a significant preface by Ida HOOS)
- LINSTONE, Harold (ed): "New perspectives on Systems Sciences" Syst. Research, 12 (2) 1995
- LINSTONE, Harold: "The changing role of forecasting" - Systems, 2(2), Polytechn. Univ. Wroclaw, Poland, 1997
- LINSTONE, Harold: "Decision making for technology executives" - Artech House, Norwood, Mass., 1999
- LINSTONE, H. & ZHU, Z.: "Towards synergy in the search for multiperspective approaches" - Human Systems Management (under review), 1999
- LIONI, Arnaud: "Des autobus à l'heure de l'intelligence collective" - Athena, nr. 165, nov. 2000
- LIPSHUTZ, Seymour: "Discrete mathematics". McGraw Hill, New York, 1976
- LIPSET, David: "Gregory Bateson: the legacy of a scientist" - Beacon Press, Boston, 1982
- LIPSON, Hod & POLLACK, Jordan: "Automatic design and manufacture of robotic lifeforms" - Nature, 406 (6799), Aug. 31st, 2000
- LISSACK, M.(ed.) : "Emergence; a journal of complexity issues in organizations and management". - L. Erlbaum, Mahwah, NJ., 1999
- LISSONI, C. & al. (Eds): "Information Systems Methodologies" - BCS Publications, Swindon, 1995
- LISZKA, James J.: "A general introduction to the semeiotic of Ch.S. Peirce" - Indiana Univ. press, Bloomington and Indianapolis, 1996
- LITTLEJOHN, S.W.: "Theories of human communication". 4th ed. Wadsworth Publ., Belmont, CA., 1992
- LIU, Michel: "Etude a-disciplinaire du réel", in "La systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, Bienne, 1989
- LIU, Michel: "Dossier sur les représentations d'une situation complexe" - Rev. Internat. Systémique, 11(3) 1997
- LIU, Michel: "La construction de représentations de situations complexes" - Rev. Internat. Systémique, 11(3) 1997
- LLEWELYN, J.: "Emmanuel Levinas: the genealogy of ethics" - Routledge, New York, 1994
- LOCKE, John L.: "Phases in the child, development of language". Amer. Scientist, 82 (5) 1994
- LOCKE, M.: "Historical trends in systems theory" - Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- LOCKER, A. (ed): "Biogenesis, evolution, homeostasis". Springer, New York, 1973
- LOCKER, A. et al.: "L'origine, le développement et la croissance des systèmes téléogénétiques". Rev. Biomat., 49, Paris, 1975
- LOCKLAND, George, T.: "Grow or die: The unifying principle of transformation". Dell, New York, 1973
- LOCQUIN, Marcel: "Catastrophes, anastrophes et évolution". Rev. de Bio-Mathématique, nr.70, 1980
- LÖCKENHOFF, Hellmut: "Simulation for decision support in societal systems". Proc.8th IDIMT, Zadov, Universitätsverlag R. Trauner, Linz, 2000
- LÖFGREN, Lars: "An axiomatic explanation of complete self-reproduction". Bul. Math. Biophysics, 30 (3), 1968
- LÖFGREN, Lars: A review of "Dynamical systems theory in biology". Intern. J. Gen. Systems, 1 (1) 1974
- LÖFGREN, Lars: "Complexity of descriptions of systems: a functional study". Intern. J. Gen. Systems, 3 (4) 1977
- LÖFGREN, Lars: "Some foundational views on general systems and the Hempel paradox". Intern. J. Gen. Systems, 4 (4) 1978
- LÖFGREN, Lars: "On complementary aspects for general systems". Intern. J. Gen. Systems, 5 (4) 1979
- LÖFGREN, Lars: "Fragmentability, a fundational systems concept" - Proc. 15th Cyb. & Syst. Meet. Austrian Soc. Cyb. Studies, Vienna, 2000
- LÖFGREN, Lars: "What is system science" - Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- LÖSCH, August: "Die räumliche Ordnung der Wirtschaft". Gustav Fischer, Jena, 1944
- LÖSCH, August: "The economics of location". Yale Univ. Press, New Haven, 1954 (Translation of 1944)
- LOEWESTEIN, M.W.: "The touchstone of life: molecular information, cell communication, and the foundation of life" - Oxford Univ. Press, Oxford, 1999
- LOLLI, Gabriele: "La perdita della certezza". Scientia, 75 (5-8) 1975 (English translation in the same issue)
- LONGHURST, Alan et al.: "The instability of ocean populations. Natural large scale fluctuations". New Scientist, June 1st, 1972
- LOOCKE, D., van : "The dynamics of concepts" - Springer Verlag, Heidelberg, 1994
- LOOCKE, D., van: "Algorithmic growth and quantum theory" - Cybernetica, XLI(2/3/4), 1998
- LOOCKE, D., van (ed.): "The structure and representation of concepts" - Routledge, London, 1998
- LOOCKE, D., van : "Problem solving based on error minimization in cellular systems with phase fields instead of connections" - CASYS J., 7, Liège, Belgium, 2000
- LOOCKE, Philip, van (ed.): "Quantum approaches to consciousness" - Benjamins, Amsterdam, 2000
- LOPEZ GARAY, Hernan: "Interpretive systemology and systemic practice" - SPAR, 12(1) 1999
- LOPEZ GARAY, Hernan: "The holistic sense of prison phenomena in Venezuela: I and II- SPAR, 12(1) 1999
- LORENZ, Edward N.: "Deterministic nonperiodic flow" - J.Atmosph.Sc. 20, p. 130-41, 1963
- LORENZ, Edward: "The Essence of Chaos" - Univ. of Washington Press, 1993
- LORENZ, Konrad: "Gestalt perception as fundamental to scientific knowledge". SGSR Yearbook, XVII, 1962
- LORIGNY, Jacques: "Les systèmes autonomes". AF-CET-Systèmes, Dunod, Paris, 1992
- LORIGNY, Jacques et al.: "Journée d'étude sur la théorie de l'autonomie selon la pensée de Pierre Vendryes". Rev. Intern. de Systémique, 9 (5), 1995
- LORIGNY, Jacques: "Une approche systémique et cognitive de la science en crise" - Rev. Internat. Systémique, 10(4) 1996

- LORIGNY, Jacques: "Une Approche Systémique et Cognitive de la Science en Crise" – Rev. Intern. de Systémique 10 (4), 1996
- LORIGNY, Jacques (ed.): "Journée d'étude sur la théorie de l'autonomie; nro. Spécial" Rev. Internat. Systémique, 11(5) 1997
- LOSICK, R. & KAISER, D.: "Why and how bacteria communicate" – Sc. Amer., p. 68-73, Feb. 1997
- LOTKA, Alfred J.: "Contribution to the energetics of evolution". Proc. Nat. Acad. Sciences, 8, 1922
- LOTKA, Alfred J.: "The law of evolution as a maximal principle". Human Biology, 17, 1945
- LOTKA, Alfred J.: "Elements of mathematical biology". Dover, New York, 1956
- LOTMAN, Yuri M.: "Universe of the mind: a semiotic theory of culture" – Taurus & Co., London, 1990
- LOUBSTER, Jan J. et al.(eds.): "Explorations in General Systems Theory in Social Science" (Essays in Honor of Talcott Parsons) – Free Press, New York, 1990
- LOVELOCK, John E.: "GAIA: a new look at life on earth". Oxford Univ. Press, 1979
- LOVELOCK, James: "Healing Gaia" – Harmony Books, New York, 1991
- LOYE, D.: "Chaos and transformation: implications of nonequilibrium theory for social science and society" – In LASZLO (1991b) p. 11-32
- LOYE, D.: "Moral sensitivity and the evolution of higher mind" – In LASZLO et al., 1993, p. 151-165,
- LUCADOU, Walter von: "Psyche und chaos" – Insel Verlag, Frankfurt, 1995
- LUCADOU, Walter von: "The exo-endo-perspective of non-locality in psycho-physical systems" – Casys J., 2, Inst.de Math., Univ. de Liège, Belgium, 1998
- LUCAS, H., LAND, F., LINCOLN, T. & SUPPER, K. (Eds): "The Information Systems Environment" – North Holland, Amsterdam, 1980
- LUCE, R. D. & RAIFFA, H.: "Games and decisions". Wiley, New York, 1957
- LUCY, John: "Language diversity and thought: a reformulation of the linguistic relativity hypothesis" – Cambridge Univ. Press, Cambridge, MA, 1992
- LUGAN, Jean Claude: "La systémique sociale". Presses Univ. de France, Paris, 1993
- LUGT, Hans: "Vortices and vorticity in fluid dynamics". Amer. Scientist, V. 73 (2), 1985
- LUHMANN, Niklas: "Soziologische Aufklärung" 6 vols. - Westdeutscher Verlag, Opladen, 1970-1995
- LUHMANN, Niklas: "The differentiation of society" - Columbia Univ. Press, New York, 1982 (orig. works publ. 1971 & 1975)
- LUHMANN, Niklas: "Trust and power" – Wiley, New York, 1979
- LUHMANN, Niklas: "Gesellschaft und Semantik". Suhrkamp, Frankfurt, 1980
- LUHMANN, Niklas: "Gesellschafts-Struktur und Semantik", Band 1 to 4 – Suhrkamp, Frankfurt, 1980-1998
- LUHMANN, Niklas: "Aus differenzierung des Rechts" - Suhrkamp, Frankfurt, 1981
- LUHMANN, Niklas: "Soziale Systeme: Grundriss einer allgemeine Theorie". Suhrkamp, Frankfurt, 1984
- LUHMANN, Niklas: "Social systems" – Stanford University Press, Stanford, CA., 1995 (original in german, 1984)
- LUHMANN, N. & SHORR, K.E.: "Reflexionsprobleme in Erziehungssystem" – Suhrkamp, Frankfurt aM, 1988
- LUHMANN, Niklas: "Ecological communication" – Polity Press, Cambridge, 1989
- LUHMANN, N. & FUCHS, P.: "Reden und Schweigen" – Suhrkamp, Frankfurt aM, 1989
- LUHMANN, Niklas: "Beobachter: Konvergenz der Erkenntnistheorien" – München, 1990
- LUHMANN, Niklas: "Die Wissenschaft der Gesellschaft" – Suhrkamp, Frankfurt, 1990
- LUHMANN, Niklas: "Erkenntnis als Konstruktion" – Benteli Verlag, Bern, 1990
- LUHMANN, Niklas: "Essays on Self-reference" – Columbia Univ. Press, New York, 1990
- LUHMANN, Niklas: "Paradigm lost: Über die ethische Reflexion der Moral" - Suhrkamp, Frankfurt aM, 1990
- LUHMANN, Niklas: "Beobachtungen der Moderne" – Westdeutsche Verlag, Opladen, 1992
- LUHMANN, Niklas: "Risk: a sociological theory" – De Gruyter, New York, 1993
- LUHMANN, Niklas: "The paradox of observing systems" – Cultural Critique, Fall, p. 37-55, 1995
- LUHMANN, Niklas: "Why Systems Theory" – C&HK, 3, (2), 1995
- LUHMANN, Niklas: "Die neuzeitlichen Wissenschaften und die Phänomenologie" – Picus, Wien, 1996
- LUHMANN, Niklas (Hg. HELLMANN, Kai-Uwe): "Protest: Systemtheorie und Soziale Bewegungen" – Suhrkamp, Frankfurt, 1996
- LUHMANN, Niklas: "Die Gesellschaft der Gesellschaft" - Suhrkamp, Frankfurt aM, 1997
- LUHMANN, Niklas: "Die Kunst der Gesellschaft" – Suhrkamp, Frankfurt aM, 1997
- LUHMANN, Niklas: "The control of intransparency" - SRBVS, 14 (6), 1997
- LUHMANN, Niklas: "Cybernetics, systems and semiotics" – C&HK., vol. 6, (3), 1999 (A special issue in honour of the late N. Luhmann- ed.: Sören Brier)
- LUHMANN, Niklas: "Sign as Form" – Cyb&HK., 6, (3), 1999
- LUHMANN, Niklas: "Aufsätze und Reden" – Philipp Reclam jr., Stuttgart, 2001
- LUMINET, Jean- Pierre: "Les trous noirs". Belfond, Paris, 1987
- LUMLEY, Ted: "Complexity and the "Learning Organization" – Complexity, 2, (5) 1997
- LUMSDEN, C.J. & WILSON, E.O.: "Genes, minds and culture: the coevolutionary process". Harvard Univ. Press, Cambridge, Mass., 1981
- LUNDSTEDT, Sven B.: "Pathogenic cybernetics". Cybernetica 38 (4) 1995
- LUPASCO, Stéphane: "Logique et contradiction". Presses Univ. de France, Paris, 1947
- LUPASCO, Stéphane: "La tragédie de l'énergie" - Casterman, Paris, 1970
- LUPASCO, Stéphane: "La logique de l'événement". Communications n 18. Le Seuil, Paris, 1972
- LUPASCO, Stéphane: "L'énergie et la matière vivante" – Julliard, Paris, 1974
- LUPASCO, Stéphane: "Les trois matières" (2ème. ed.) – Cohérence, Strasbourg, 1982
- LUPASCO, Stéphane: "Le Principe d'Antagonisme et la logique de l'énergie", Le Rocher, Paris, 1987
- LUPASCO, Stéphane: "L'énergie et la matière psychique" (2ème. ed.) - Ed. Le Rocher, Paris, 1987
- LUPASCO, Stéphane: "L'expérience microphysique et la pensée humaine (2ème ed.) Ed. Le Rocher, Paris, 1989
- LURIA, A.R.: "The working brain: An introduction to neuropsychology" – Basic Books, New York, 1973
- LURIA, A.R.: "Basic problems of Neurolinguistics"- Mouton, The Hague, 1976
- LURIA, A.R.: "Higher Cortical Function in Man" - Basic Books, New York, 1980
- LUTZ, C. & WHITE, G.M.: "The anthropology of emotions" – Ann. Rev. Anthr., 15, 1986
- LYNCH, A.: "Thought contagion: how belief spreads through society" - Basic Books, New York, 1996
- LYNCH, G.: "Synapses, Circuits and the Beginnings of Memory" – MIT Press, Cambridge, 1986
- LYOTARD, J.F.: "The differend: phrases in dispute" – Univ. Minnesota Press, Minneapolis, 1988 (french orig. work publ. 1983)
- LYOTARD, J.F.: "The postmodern condition: a report on knowledge" – Manchester Univ. Press, Manchester, UK., 1984
- LYOTARD, J.F.: "The Lyotard reader" (A. BENJAMIN, ed.) – B. Blackwell, Cambridge, 1989
- LYYTINEN, K.: "Information systems development as social action: Framework and critical implications" – PhD Thesis, Dept. of Computer Science, University of Jyväskylä, Finland, 1986
- LYYTINEN, K & HIRSCHHEIM, R.: "Information systems as rational discourse: an application of Habermas's theory of communicative action" – Scandinavian Journ. of Management, 4, 1988
- M'PHERSON, P.K.: "Systems and systems science? An attempt to answer some ontological and epistemological questions". J.Appl.Syst.Anal., 7, 1980, p. 409-420
- MACARTHUR, R.H.: "Fluctuations of animal populations, and a measure of community stability". Ecology, 36, 1955
- MACARTHUR, R.H. and WILSON, E.O.: "The Theory of Island Biogeography" – Princeton Univ. Press, 1967
- MACCANNELL, D. & J.F.: "The time of the sign: a semiotic interpretation of modern culture" – Bloomington, Indianapolis, 1982
- MACCIA, George G.: "Genetic epistemology of intelligent systems", in G. Lasker: "Adv. in Syst. Research and Cybernetics": Univ. of Windsor, Ontario, Canada, 1988
- MACGINNIS, William & KUZIORA, Michael: "The Molecular Architects of Body Design". Sc. American., Febr. 1994
- MACHLUP, F. & MANSFIELD, U.(eds.): "The study of information; interdisciplinary messages"- Wiley, New York, 1983
- MACKAY, Donald: "Mindlike behavior in artifacts". British J. Phil. of Science, 1 (2), 1951-52
- MACKAY, Donald: "On comparing the brain with machines". Am. Scientist, V.42, 1954
- MACKAY, Donald: "Epistemological problems for automata", in Shannon, C.E. & Mc Carthey, J. (eds.): "Automata studies". Princeton Univ. Press, 1956
- MACKAY, Donald: "Information, mechanism and meaning". MIT Press, Cambridge, Mass., 1969
- MACKAY, Donald M.: "The wider scope of information theory" (in Machlup & Mansfield (eds.) 1983

- MacKENZIE, Dana: "On a roll: Understanding Randomness" - N.Sc., Nr.2211, November, 6th, 1999
- MacKENZIE, Debora: "Never again" - N.Sc., Nr. 2164, December 12th. 1998
- MacLEAN, P.D.: "A Mind of Three Minds: Educating the Triune Brain" - in CHALL, Jane & MIRSKY, Allan (Ed): "Education and the Brain" - Univ. of Chicago Press, 1978
- MAES, Pattie: "The agent network architecture". (ANA) Sigart, 2 (4) 1991
- MAE-WAN, Ho: "The rainbow and the worm: the physics of organisms" - World Scientific, Singapore, 1993
- MAINZER, K.: "Thinking in Complexity"- 3rd Ed. - Springer, New York, 1997
- MAILOT, Fernand: "La nouvelle cybernétique". Chabassol, Brussels, 1982
- MAISEL, Sherman, J.: "Fluctuations, growth and forecasting". Wiley, New York, 1957
- MAKABE, Pedro: "El cambio epistemológico. Paradigmas en ciencia, medicina y psiquiatría" - E. San Marcos, Lima, Peru, 1989
- MAKARENKO, Alexander: "Neuronet approaches in system analysis and modelling of large social ecological and economical systems" - 42nd. Ann.conf. of ISSS, Georgia Technology Institute, Atlanta, 1998
- MAKARENKO, Alexander: "Asymmetry, observer and perception problems" - CASYS,J., 7, Liège, 2000
- MAKRIADIS, Spiros: "The second law of systems". Intern. J. Gen. Systems, 4 (1) 1977
- MALASKA, P.: "Economic and social evolution: the transformational dynamics approach" - In LASZLO (1991), p. 131-156
- MALIK, F.: "Kybernetische und methodische Grundlagen des Strategischen Management" - Bern, 1979
- MALIK, F.: "Praxis des systemorientierten Management" - Bern, 1979
- MALIK, F.: "Strategie des Managements komplexer Systeme" - 3te. Aufl.- Bern, 1989
- MALIK, M.F. et al.: "The notion of human values from the biocybernetic point of view", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- MALMSJÖ, A. & ÖVELIUS, E.: "Factors that induce change in information systems"- SRBVS, 20(3) 2003
- MALTA MACEDO, Henrique: "Metaphorical structures of the self". Cyb. & Systems Research 92, World Scientific, Singapore, 1992
- MANDEL, Thomas: "The four winds: meta-perspectivalism and perspectivalism: the one and the many" - Proc. 42nd ISSS conf., Atlanta, 1998
- MANDELBROT, Benoit: "Fractals, forms, chance and dimension". Freeman, San Francisco, 1977
- MANDELBROT, Benoit: "The many faces of scaling", in Schieve, W.C. & Allen, P.M. (eds.): "Self organization and dissipative structures". Univ. of Texas, Austin, 1982
- MANDELBROT, Benoit: "The fractal geometry of nature". Freeman, New York, 1983. In French: "Les objets fractals". Flammarion, 2ème Ed., 1985
- MANESCU, Manea: "Economic cybernetics". Abacus, Tunbridge Wells, Engl., 1980
- MANTHEY, Michael: "Distributed computation, the twisted isomorphism and autopoiesis"- Dpt. of Computer Science, Aalborg Univ., 1997
- MANTHEY, Michael: "Distributed computation, the twisted isomorphism and autopoiesis" - Casys J., 1, Inst.de Math., Univ. of Liège, Belgium, 1998
- MANTZ, M.R.: "Systems theory and evolution". Annals of Systems Research, 1, Systeem Groep Nederland, 1971
- MANZELLI, Paolo: "Conceptual tools". in B. Banathy & R. Rodriguez Delgado (eds): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- MARCER, P.J. & SCHEMP, W.: "The brain as a conscious system" - Int.J.Gen.Syst., 27, (1/3), 1998
- MARCER, P.J.: "Anticipation and meaning"- CASYS, Liège, 2000
- MARCH, J.G. & SIMON, H.A.: "Organization" 2nd ed. - Blackwell, Cambridge, 1993
- MARCHAIS, P. & RANDRUP, A.: "Le phénomène moral; approche psychiatrique et interdisciplinaire"- Privat, Toulouse, France, 1989
- MARCHANT, Joanna: "A little light healing" - N.Sc., Nr.2228, 4 March 2000
- MARGALEF, Ramón: "Information theory in Ecology". SGSR Yearbook 3, 1958
- MARGALEF, Ramón: "Perspectives in ecological theory". Univ. of Chicago Press, Chicago, 1968
- MARGALEF, Ramón: "La biosfera: entre la termodinámica y el juego". Omega, Barcelona, 1980
- MARGALEF, Ramón: "Ecología". Omega, Barcelona, 1982
- MARGOLIS, H.: "Selfishness, Altruism and Rationality"- Cambridge Univ. Press, 1982
- MARGULIS, L. & FESTER, R. (Eds.): "Symbiosis as a source of Evolutionary Innovation: Speciation and Morphogenesis"- MIT Press, Cambridge, MA, 1991
- MARGULIS, L. & McMENAMIN, M. (Eds): "Concepts of Symbiogenesis: A Historical and Critical Study of the Research of Russian Botanists" - Yale Univ. Press, Newhaven, CT, 1993
- MARGULIS, Lynn: "Symbiosis in Cell Evolution"- 2nd ed.- Freeman, New York, 1993
- MARIAS, Julián: "Reason and life". Greenwood Press, Westport, Conn., 1975
- MARKELY, O.W. & HARMAN, W.: "Changing images of man" - Pergamon Press, London, 1982
- MARKHOFF, Gérard (Ed.): "Vers une éthique politique. L'éthique face à l'ingouvernabilité du monde actuel" - Maison des Sciences de l'Homme, Paris, 1987
- MARKOV, A.A.: "Theory of algorithms". Acad. of Sciences USSR, 1954 (Trans. publ. by The Israel Prog. for Scient. Transl., Jerusalem, 1962)
- MARKS-TARLOW, Terry et al.: "Varela and the uroboros: The psychological significance of reentry"- C&HK, 9(2) 2002
- MARNEY, M.C. & SMITH, N.M.: "The domain of adaptive systems: a rudimentary taxonomy". SGSR Yearbook, 9, 1964
- MARNEY, M.C. & SMITH, N.M.: "Evolution of scientific method". in Jantsch, E. & Waddington, C.(eds): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1970
- MARSDEN, Paul: "Mental Epidemics"- N.Sc., Nr.2237, May 6th, 2000
- MARTENS, Heinrich & ALLEN, Don: "Introduction to Systems theory". Merrill Publ., Columbus, 1969
- MARTIAL, F. von : "Coordinating plans of autonomous agents" - Springer, Berlin, 1992
- MARTIN, C.C. & GORDON, R.: "The evolution of perception (from bacteria to man)- Proc. 15th Meeting on Cybernetics and Systems, Vienna, 2000
- MARTIN, H. et al. (eds.): "Technologies of the self" - Tavistock, London, 1988
- MARTINELLI, Dante: "Systems hierarchies and management"- SRBVS, 18(1) 2001
- MARTINEZ, Silvio: "General rules for system dynamics modelling". in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- MARTINEZ ALIER, Joan & SCHLÜPMANN, Klaus: "La Ecología y la Economía " - Fondo de Cultura Económica, Mexico, 1993
- MARTINO, Joseph: A review of Berlinski's "On systems analysis". ASC Cyb. Forum, 9 (4) 1979
- MARTINO, J.P.: "Technological forecasting for decision making". 2ed.-Elsevier, North Holland, New York, 1983
- MARTINOLI, A. et al.: "Quand les robots imitent la nature" - La Recherche, nro. 358, nov. 2002
- MARUYAMA, Magoroh: "Morphogenesis and morphostasis". Methodos, 11 (p.251-95), 1960
- MARUYAMA, Magoroh: "Communicational epistemology"- British J.Phil.Sc., v.11, 1961
- MARUYAMA, Magoroh: "Generating complex patterns by means of simple rules of interaction". Methodos, 14, (p.17-26), 1963
- MARUYAMA, Magoroh: "The 2nd. Cybernetics: deviation-amplifying mutual causal processes". Amer. Scientist, 51 (2) 1963 (Also in W. Buckley (ed): "Modern Syst. Res..." and in Cybernetica, 6 (1), 1963
- MARUYAMA, Magoroh: "Metaorganization of information". SGSR Yearbook, XI, 1966
- MARUYAMA, Magoroh: "Mutual causality in general systems", in Milsom, J. (ed.): "Positive feedback". Pergamon, New York, 1968
- MARUYAMA, Magoroh: "Paradigmatology: Cross-disciplinary, professional and cultural communication". Cybernetica, 17 (4), 1973
- MARUYAMA, Magoroh: "Toward cultural symbiosis", in Jantsch, E & Waddington, C.(ed.): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1976
- MARUYAMA, Magoroh: "Heterogeneistics". Cybernetica, 20 (1), 1977
- MARUYAMA, Magoroh: "Mindscapes". World Future Society Bull. nr.13, 1979
- MARUYAMA, Magoroh: "Experience looping, design looping and concept crossing". Futures, 17 (4) 1985
- MARUYAMA, Magoroh: "From classificational learning to morphogenetic learning". Cybernetica, 32 (2) 1989
- MARUYAMA, Magoroh: "Context and complexity: cultivating contextual understanding"- Springer, New York, 1992
- MARUYAMA, Magoroh: "Entropy, beauty and eumorph". Cybernetica, 35 (3) 1992
- MARUYAMA, Magoroh: "A quickly understandable notation system of causal loops for strategy decision makers". Cybernetica, 36 (1) 1993
- MARUYAMA, Magoroh: "Mindscapes in management". Dartmouth, Cambridge Univ. Press, UK., 1994

- MARUYAMA, Magoroh: "Individual epistemological heterogeneity across cultures" - *Cybernetica*, v.37, 1995
- MARUYAMA, Magoroh: "Relationality, outbreeding and direct contextual experiencing for future social sciences" - *Cybernetica*, v. XLI(2/3/4), 1998
- MARUYAMA, Magoroh: "Mindscapes and science theories". *Curr. Anthropol.*, 5 (p.589-608)
- MARX HUBBARD, Barbara: "Conscious evolution: the next stage of human development" - *SRBVS*, 20(4) 2003
- MASANI, P.R.: "The illusion that man constructs reality". *Kybernetes*, 21 (4) 1992
- MASANI, P.R.: "The scientific methodology in the light of cybernetics". *Kybernetes*, 23 (4) 1994
- MASANI, P.R.: "Wiener's cybernetics and its societal implications". *Cybernetica*, 38 (4) 1995
- MASLOW, A.H.: "Motivation and personality" - Harper & Row, New York, 1954
- MASON, Richard O.: "A general systems theory of productivity". *Intern. J. Gen. Systems*, 5 (1) 1979
- MASS, Nathaniel J.: "Economic cycles: An analysis of underlying causes". Wright Allen Press, Cambridge, Mass, 1975
- MASSANI, P.R.: "Norbert WIENER's book "Cybernetics" and the prospect of a new era of human slavery" - *Cybernetica*, XLI (2-4), 1998
- MATSUNO, Koichiro: "The uncertainty principle as an evolutionary engine" - *Biosystem*, 27, 1992
- MATSUNO, Koichiro: "Consumer power as the major evolutionary force" - *J.Theor.Biol.*, 173, 1995
- MATSUNO, Koichiro: "A nature of variations making evolution possible" - *CASYS J.*, 2, Inst. of Math., Univ. of Liège, Belgium, 1998
- MATTEACCIOLI, Andrée: "Une approche évolutionniste de la croissance et de l'équilibre dans un "univers en expansion" (about G. PALOMBA's work: "L'expansion capitalista") *Rev. Internat. Systémique*, 11(3) 1997
- MATTESICH, Richard: "Instrumental reasoning and systems methodology". Reidel, Dordrecht, 1978
- MATTESICH, Richard: "Axiomatic representation of the systems framework". *SGSR Yearbook*, XXVII, 1982
- MATTESICH, Richard: "The systems approach: Its variety of aspects". *J. Amer. Soc. of Inform. Science*, 33 (p.383-94), 1982
- MATTHEWS, Robert: "Far Out Forecasting" - *New Scientist*, Nr. 2051, 12 Oct. 1996
- MATTHEWS, Robert: "Faith, hope and statistics" - *N.Sc.*, Nr. 2109, 22 Nov. 1997
- MATTHEWS, Robert: "How right can you be ?" - *N.Sc.*, Nr. 2072, 8 March 1997.
- MATTHEWS, Robert: "Six degrees of separation" - *N.Sc.*, Nr.2137, 6 June 1998
- MATTHEWS, Robert: "Get connected" - *N.Sc.*, Nr.2215, 4 December 1999
- MATTHEWS, Robert: "Base Instincts" - *N.Sc.*, Nr.2223, 29 Jan. 2000
- MATURANA, Humberto: "Biology of cognition". (Report nr.90, Biol. Comp. Lab.), Univ. of Illinois, Urbana, 1970
- MATURANA, Humberto: "Neurophysiology and cognition", in Garvin, P.L.(ed): "Cognition: a multiple view". Spartan Books, Washington, 1970
- MATURANA, H. & VARELA, F.: "De máquinas y seres vivos". Ed. Univ. Santiago de Chile, 1973
- MATURANA, Humberto: "Stratégies cognitives", in Morin, E. & Piatelli-Palmarini, M. (eds): "L'unité de l'homme". Le Seuil, Paris, 1974
- MATURANA, Humberto: "The organization of the living". *Intern. Man-Machine Studies*, 7, 1975
- MATURANA, Humberto: "The wholeness of the unity: conversations with H. von Foerster". *ASC Cyb. Forum*, IX (3) 1979
- MATURANA, H. & VARELA, F.: "Autopoiesis and Cognition". Reidel, Boston, 1980
- MATURANA, Humberto: "The biology of cognition", in Maturana, H. & Varela, F. (eds): "Autopoiesis of cognition". Reidel, Boston, 1980
- MATURANA, Humberto: "Autopoiesis", in Zeleny, M. (ed) "Autopoiesis, a theory of living organization". North Holland, New York, 1981
- MATURANA, Humberto: "Die organization und Verkörperung von Wirklichkeit". Vieweg, Braunschweig, 1982
- MATURANA, H. & VARELA, F.: "El árbol del conocimiento". Edic. Univ. Santiago de Chile, 1984 (in English: "The tree of knowledge" Shambala, 1987)
- MATURANA, Humberto R.: "Reality: The search for objectivity or the quest for a compelling argument?" - *Irish Journal of Psychology*, V. 9, 1988
- MATURANA, H. & VERDEN-ZÖLLER: "Liebe und Spiel: die Vergessene Grundlage des Menschlichkeit" - Carl Auer Verlag, Berlin, 1993
- MATURANA, H. & al.: "Desde la Biología a la Psicología" - Edit. Universitaria, Santiago de Chile, 1996
- MATURANA, Humberto: "La Objetividad: Un Argumento para Obligar" - Dolmen, Santiago de Chile, 1997
- MATURANA, Humberto: "The effectiveness of mathematical formalisms". *C&HK*, 7(2-3) 2000
- MATURANA, Humberto: "The nature of the laws of nature" - *SRBVS*, 17(5) 2000
- MATURANA, Humberto: "Autopoiesis, structural coupling and cognition" - *C&HK*, 9(3-4), 2002
- MAY, Robert: "Stability and complexity in model ecosystems". Princeton Univ. Press, 1973
- MAY, Robert: "Biological populations with stable points, stable cycles, chaos". *Science*, 186, nr. 4164, 1974
- MAY, R. M. & OSTER, G.F.: "Bifurcatifons and dynamic complexity in simple ecological models". *Amer. Naturalist*, 110, 1976
- MAY, Robert M.: "Simple mathematical models with very complicated dynamics". *Nature*, 261, jun. 1976
- MAY, Robert M.: "Thresholds and break points in ecosystems with a multiplicity of stable states". *Nature*, 269, (p. 471-77), 1977
- MAY, Robert M.: "Chaos and the dynamics of biological populations". *Proc. Royal Soc.*, A413, London, 1987
- MAYER-KRESS, Gottfried: "Fractals". *Phys. Bull.* 39(9) sept. 1988
- MAYNARD SMITH, J.: "The Evolution of Social Behavior - A Classification of Models" - in King's College Sociology Group.(ed.) : "Current Problems in Sociobiology", Cambridge Univ. Press, UK, 1982
- MAYNARD SMITH, J. & SZATHMARY, E.: "The Major Transitions in Evolution" - Oxford-Freeman Press, 1995
- MAYON-WHITE, B. & HUMPHREYS, P. (eds.): "Decision support in organizational transformation"- IFIP Conference, W.G., 1994
- MAYR, E.: "The growth of biological thought"- Harvard Univ. Press, Cambridge, MA, 1982
- McROBIE, A. & THOMPSON, M.: "Chaos, catastrophes and engineering". *New Scientist*, June. 9, 1990
- McADAMS, S. & DELIEGE, I.: "La musique et les sciences cognitives" - Mardaga, Bruxelles, 1988
- McCAULEY: "Chaos, dynamics and fractals: an algorithmic approach to deterministic chaos" - Cambridge Univ. Press, 1995
- Mc CLELLAND, Charles: "General systems and the social sciences". ETC., 18, 1962
- Mc CLELLAND, J.L. et al: "Parallel distributed processing explorations in the microstructure of cognition". 2 vol. MIT Press, Cambridge, Mass., 1986
- McCLINTOCK, Peter & LUCHINSKY, Dmitri: "Glorious noise" - *N.Sc.*, Nr 2168, January 9, 1999.
- Mc CORMICK, Sue & WATERS, Tim: "Preparing Educational Learning Communities for Change by Design". *Cyb. & Systems*, 27 (6), 1996
- Mc CRONE, John: "Computers that listen". *New Scientist* n° 1902, dec.4, 1993
- McCRONE, John: "Left Brain, Right Brain" - *N.Sc.*, Nr. 2193, July 3rd, 1999.
- Mc CULLOCH, W.S. & PITTS, W.: "A logical calculus of the ideas immanent in nervous activity". *Bull. Math. Biophys.* (5) 1943
- Mc CULLOCH, Warren: "Finality and form". Thomas, Springfield, IL, 1952
- McCULLOCH, Warren: "Through the Den of the Metaphysician" - *Brit.J.Phil. Sc.*, 5 (17), May 1954
- Mc CULLOCH, Warren S.: "Embodiments of mind". MIT Press, Cambridge, Mass., 1965 (reprinted 1989)
- Mc CULLOCH, Warren S.: "Recollections of the many sources of cybernetics". *ASC Cyb. Forum*, VI (2) 1974
- McCULLOCH, Warren: "Collected works of Warren McCulloch" (4 Vols.)- Intersystems, Salinas, 1989
- McDANIEL, E. & LAWRENCE, C.: "Levels of cognitive complexity: an approach to measurement of thinking" - Springer, New York, 1990
- McDONNELL, M.J. & PICKETT, S.T.: "Humans as Components of Ecosystems"- Springer, New York, 1993
- McFARLAND, D.: "Animal behavior: psychology, ethology and evolution" - Benjamin Cumming, Menlo Park, CA, 1985
- Mc INNIS, Noel: "Gestalt ecology". *Fields within fields*, 2 (1) 1969
- McINTOSH, D.: "Language, self, and lifeworld" in HABERMAS's "Theory of Communicative Action" - Theory and Society, Vol. 23, 1994
- McINTYRE, Janet: "Consideration of categories and tools for holistic thinking"- *SPAR*, 11(20) 1998
- McINTYRE, J. & PADHAN, M.: "A systemic approach to addressing complexity of energy problems"- *SPAR*, 16(3) 2003
- Mc INTYRE BOYD, Gary: "Educating symbiotic p-individuals through multi-level conversation". *Syst. Research*, 10 (3) 1993
- McLUHAN, & POWERS, B.: "The global village: transformation in world life in the 21st Century"- Oxford Univ. Press, 1989

- McNAMARA, Curt: "Applied systems thinking: thinking about thinking"- Proc. 42nd ISSS conference, Atlanta, 1998
- McNAMARA, Curt: "Laws of geometric systems"- SRBVS, 18(5), Sept.-oct. 2001
- McNAMARA, Ken: "Embryos and Evolution" - Inside Science Nr.124, N.Sc. Nr.2208, Oct 16th, 1999
- Mc NEIL, Donald H.: "Re-framing systemic paradigms for the art of learning". Conf. Amer. Soc. Cyb., 1993a
- Mc NEIL, Donald H.: "Architectural criteria for a General Theory of Systems". Proc.ISSS Conf., 1993b
- Mc NEIL, Donald A.: "A survey of applied Systemology". Syst. Research, 12 (2) 1995
- McNEILL, D. & FREIBERGER, P.: "Fuzzy logic"- Simon & Schuster, New York, 1993
- Mc PHERSON, P.K.: "A perspective on systems science and systems philosophy". Futures, 6 (3), 1974
- McSHEA, D.W.: "Mechanisms of large-scale evolutionary trends"- Evolution, V.48, 1994
- MC WHINNEY, W. & BUSHNELL, D.: "Education for systems practice". Syst. Research 4 (41) 1987
- McWHINNEY, Will: "Of paradigms and system theories"- Enthusion Inc., Venice, CA, 1991
- McWHINNEY, Will: "The matter of Einstein Square dance with Magritte"- C&HK, 3(3), 1995
- Mc WHINNEY, Will: "Paths of change"- Sage Publ., Thousand Oaks, CA, 1997
- McWHINNEY, Will: "Praxis: beyond theory and practice"- C&HK, 4(2/3) 1997
- Mc WHINNEY, Will: "Synopsis of six systems theories"- Enthusion Inc., Venice, CA, 1997
- MEAD, G.H.: "Mind, self and society" - The Univ. of Chicago Press, Chicago, 1962
- MEADOWS, D. et al.: "The limits to growth". Universe Books, New York, 1972
- MEADOWS, D.H. et al.: "Dynamics of growth in a finite world" - Wright Allen Press, Cambridge, 1974
- MEADOWS, D.H. et al.: "Toward global equilibrium: collected papers for the Limits to Growth" - Wright Allen Press, Cambridge, 1974
- MEADOWS, D. et al.: "Groping in the dark". Wiley, New York, 1982
- MEAKIN, Paul: "Scaling and Growth far from equilibrium" - Cambridge University Press, 1998
- MEDINA MARTINS, P.O. & ROCHA, L.: "The 'in' and the 'out': an evolutionary approach". Cybernetics & Systems Research 92. World Scientific, Singapore, 1992
- MEDVEDEVA, T. & UMPLEBY, S.: "Social learning through process improvement in Russia"- Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- MEHL, Lucien: "Systémique et droit"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- MEIER, Richard L.: "Hybrid vigor in acculturation: The Puerto Rican transformation". SGSR Yearbook, VI, 1961
- MELESE, J.: "L'Analyse modulaire des systèmes de gestion". Editions Hommes et Techniques, Paris, 1972
- MELESE, Jacques: "Approche systémique des organisations: Vers l'entreprise à complexité humaine" - Hommes et Techniques, Boulogne-Billancourt, 1979
- MELESE, Jacques: "La gestion par les systèmes" (6ème édition) - Ed. Hommes et Techniques, Paris, 1986
- MELESE, Jacques: "L'état de l'existant"- Rev. Internat. Systémique, 11(4) 1997
- MENZEL, P. et d'ALUISIO, F.: "Robo sapiens: une espèce en voie d'apparition" - Autrement, Paris, 2001
- MERELL, Floyd: "Signs grow: semiosis of life processes"- Toronto Univ. Press, Toronto, 1996
- MEREZHKOVSKY, K.C.: "La Plante considérée comme un Complexe symbiotique" - Soc. des Sciences Naturelles de l'Ouest de la France, Bulletin, 6, p.17-98, 1920
- MERINO, Enrique: "Self organization in Stylolites". Amer. Scientist, 80 (5) 1992
- MERKER, S.L.: "Application of living systems theory to community problems - Proc. SGSR, 1981
- MERLEAU-PONTY, Maurice: "Phénoménologie de la perception". NRF, Paris, 1945
- MERLEAU-PONTY, Maurice: "The phenomenology of perception" - The Humanities Press, New York, 1962 (orig. in french "Phénoménologie de la perception" - NRF, Paris, 1945)
- MERLEAU-PONTY, Maurice: "Sense and non-sense" - Northwestern Univ. Press, Evanston, 1964 (orig. work publ. 1948)
- MERLEAU-PONTY, Maurice: "Signs" - Northwestern Univ. Press, Evanston, 1964 (orig. in french publ. 1960)
- MERLEAU-PONTY, Maurice: "The structure of behavior" - Beacon Press, Boston, 1963 (orig. in french: La structure du comportement. Presses Univ. de France, Paris, 1960)
- MERLEAU-PONTY, Maurice: "The primacy of perception"- Northwestern Univ. Press, Evanston, 1964
- MERLEAU-PONTY, Maurice: "The visible and the invisible" - Northwestern Univ. Press, Evanston, 1968
- MERRIAM, G. & C.: "Webster's 3rd. International Dictionary". Ph. B. Gove, Springfield, Mass., 1961
- MERRY, Uri: "Coping with uncertainty: chaos, self-organization and complexity" - Praeger, Westport, CT., 1995
- MERRY, Uri: "Organizational strategy in different landscapes: a new science approach" - SPAR, 12 (3), 1999
- MESAROVIC, Mihailo: "The control of multivariable systems". M.I.T. Press, Cambridge, Mass., 1960
- MESAROVIC, Mihailo (ed): "Views on G.S.Theory". Proceedings of the 2nd Systems Symposium at Case Institute of Technology. Wiley, New York, 1964
- MESAROVIC, Mihailo: "On some metamathematical results as properties of General Systems". Mathematical Systems Theory, 2 (4) 1968
- MESAROVIC, M. et al.: "Theory of hierarchical multi-level systems". Academic Press, New York, 1970
- MESAROVIC, Mihailo: "Conceptual basis for a mathematical theory of General Systems". Kybernetes, 1 (2), 1972
- MESAROVIC, M. et al.: "Satisfaction principle in modelling biological functions". Kybernetes, 2 (2) 1973
- MESAROVIC, M. & PESTEL, E.: "Mankind at the turning point: the second report to the Club of Rome" - Dutton, New York, 1974
- MESAROVIC, M. & TAKAHARA, Y.: "General Systems Theory: Mathematical foundations". Academic Press, New York, 1975
- MESAROVIC, M.D. & TAKAHARA, Y.: "Abstract systems theory" - Springer Verlag, Berlin, 1989
- MESJASZ, Czesław: "Systems metaphors, Systems analogies and present changes in international relations". Cyb. & Systems Research 92. World Scientific, Singapore, 1992
- MESJASZ, C.: "Evolution of metaphors of organization and development of information society"- Proc. 16th Meet. of Cyb. & Syst., Vienna, 2002
- METCALF, Gary: "Change, choice, and function" - Proc. 15th Cybernetics & Systems Meeting. Austrian Soc. for Cybern. Studies, Vienna, 2000
- METRAUX, A. & WALDENFELS, B.(eds.): "Leibhaftigste Vernunft"- W.Fink Verlag, München, 1986
- METZINGER, T.: "Neural correlates of consciousness: empirical and conceptual questions"- MIT Press, Cambridge, MA, 2000
- MEYER, François: "Problématique de l'évolution". Presses Univ. de France, Paris, 1954
- MEYER, François: "La surchauffe de la croissance". Fayard, Paris, 1974
- MEYER, Jean Arcady: "Les animaux artificiels sont-ils pour demain" - La Recherche, nro. 313, octobre 1998
- MEYER, Jean Arcady, et al.: "From animals to animats" - Proc. 6th Intern.Conf. on the Simulation of adaptive behavior" - MIT Press, Cambridge, MA, 2000
- MICHAELS, M. (ed.): "Proceedings of the Conferences of the Chaos Network" - Urbana, Illinois: people technologies, 1991/1994
- MICHENER, C.D.: "The social behavior of the bees". Harvard Univ. Press, Cambridge, MA., 1974
- MIDGLEY, Gerald: "Critical Systems and the problem of pluralism". Cyb. & Systems, 20 (3), 1989
- MIDGLEY, Gerald: "Pluralism and the legitimization of systems science". Syst. Practice, 5 (2) 1992
- MIDGLEY, Gerald: "Ecology and the poverty of Humanism: A Critical Systems perspective". Syst. Research, 11 (4) 1994
- MIDGLEY, Gerald: "Mixing Methods: Developing Systemic Intervention" - Research Memorandum Nr.9 - University of Hull, 1995
- MIDGLEY, Gerald & WILBY, Jennifer (Eds): Proceedings of the 1995's Beijing Conference on Systems, Univ. of Hull, 1995
- MIDGLEY, Gerald: "Systemic intervention: a critical systems perspective"- in Midgley, G. & Wilby, J.(eds.) Proceedings of the 1995's Beijing Conference on Systems, Univ. of Hull, 1995
- MIDGLEY, Gerald & WILBY, Jennifer (Eds): "Systems Methodology: Possibilities for cross-cultural learning and integration" - Centre for Systems Studies, Univ. of Hull, England, 1995
- MIDGLEY, Gerald: "Dealing with Coercion: Critical Systems Heuristics and Beyond" - Syst. Practice 10 (1), 1997
- MIDGLEY, Gerald: "Rethinking the Unity of Science" - Research Memorandum Nr.19 - University of Hull, 1998
- MIDGLEY, G. et al.: "Dealing with human relations in chinese systems practice"- SPAR, 13(1) 2000
- MIDGLEY, Gerald: "Systemic intervention: philosophy, methodology and practice"- Kluwer, Plenum, New York, 2000

- MIDGLEY, G. & WILBY, J.: "Systems practice in China: New developments and cross-cultural collaboration" - SPAR, 13(1), 2000
- MIDGLEY, G. & OCHOA ARIAS, A.E.: "Unfolding a theory of systemic intervention" - SPAR, 14 (5) 2001
- MIDGLEY, Gerald: "Science as systemic intervention; some implications of systems thinking and complexity for the philosophy of science" - SPAR, 16 (2) 2003
- MIERMONT, Jacques: "Les conditions formelles de l'état autonome". Rev. Intern. de Systémique, 3 (3) 1989
- MIESCHER, K.: "Gegensätzlichkeit und Wirklichkeit" - Dialectica, 9 (3/4), 1955
- MIKULECKY, Donald C.: "Robert Rosen: the well-posed question and its answer-why are organisms different from machines?" - SRBVS, 17(5), 2000
- MILES, Ralph Jr. (ed): "Systems concepts: Lectures on approach to systems". Wiley, New York, 1973
- MILLER, George A.: "The magical number seven: plus or minus two: some limits of our capacity to process information". Psychol. Rev., 63, 1956
- MILLER, James G.: "Living systems: basic concepts". Behav. Science, 10, 1965; 17, 1972
- MILLER, James G.: "Living Systems". Mc Graw Hill, New York, 1978
- MILLER, James G.: "Can systems theory generates testable hypothesis?" Syst. Research, 3 (2) 1986
- MILLER, J.G. & MILLER, J.: "Introduction: the nature of living systems". Behav. Science, 35 (3) 1990
- MILLER, J.G. & MILLER, J.L.: "Applications of living systems theory" - Systems Research, 8 (1) p. 19-45, 1995
- MILLER, James Grier: "LST: bridging the biological and social sciences" - Proceed. 42nd. ISSS Meeting, Atlanta, 1998
- MILLER, Jessie L.: "The timer". Behav. Science, 35 (3) 1990
- MILLER, Jessie L.: "A Look Back at the Systems Society". Behav. Science 41 (4), 1996
- MILLER, Joan: "French structuralism: a multi-disciplinary bibliography" - Garland, New York, 1981
- MILLIKAN, A.G.: "Language, thought and other biological categories: New foundation for realism" - MIT Press, Cambridge, MA, 1984
- MILLINGTON, T. Alaric & William: "Dictionary of mathematics" Barnes & Noble, Cranbury, NJ., 1971
- MILSUM, John H.(ed): "Positive feedback". Pergamon, New York, 1968
- MINAI, Asghar T.: "Architecture as environmental communication" - Mouton, Berlin, 1984
- MINAI, Ashgar T.: "Aesthetics, mind and nature: unity of matter and consciousness" - Praeger, Westport, CT, 1993
- MINAI, Ashgar T.: "Emergence: a domain where the distinction between conception in art and sciences is meaningless" - C&HK, 3(3) 1995
- MINATI, Gianfranco: "Designing Open Systems: Language, Semantics and Systems" - 2nd European School of Systems Science, UNESCO, Strasbourg, 1992
- MINATI, Gianfranco: "Designing open systems: semantics and systems learning", in Banathy, B. & Rodriguez Delgado, R. (eds) "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- MINATI, Gianfranco: "Semantic Correlation System (SCS): Verso la realizzazione pratica" - Copyright n/ 340946, Milano, 1994.
- MINATI, Gianfranco: "Uno Strumento per il Semantic Information Retrieval (SIR)" - Synthesis, Di Renzo Editore, Roma, 1994
- MINATI, Gianfranco: "Introduzione alla sistémica". Oppi Edizione, Milano, 1996
- MINATI, G., PENNA, P. & PESSA, E.: "Towards a General Theory of logically open Systems" - 3rd. Europ. Conf. of the Europ. Systems Union, Edizioni Kappa, Roma, 1996
- MINATI, G., PENNA M.P. & PESSA E.: "A conceptual framework for self organization and merging processes in social systems" - in "Systems for sustainability" - Plenum Press, New York, 1997
- MINATI, Gianfranco & COLLEN, Arne: "Introduction to Systemics" - Eagleye Books, Walnut Creek, Cal, 1997
- MINATI, Gianfranco: "Production of Knowledge in Social Systems" - Proc. World Multiconference on Systemics - Caracas, Venezuela, 1997a
- MINATI, Gianfranco: "The Future for Beings able to design" - Proc. "Sistémica" Conference, Lima, Peru, 1997b
- MINATI, G. & RESCONI, G.: "Detecting Meaning" - 3rd Europ. Conf. of the Europ. Systems Union, Roma, 1998
- MINATI, G., PESSA, E. & PENNA M.P.: "Thermodynamical and logical openness" - SRBVS, Vol.15, Nr.3, 1998
- MINATI, Gianfranco: "Conceptual frameworks for the representation of growth, development and sustainability" - Proceed. 42nd. ISSS Conference, Atlanta, 1998
- MINATI, Gianfranco: "Sistémica: Etica, Virtualità, Didattica, Economia" - Apogeo, Scientifica, Milano, 1998a
- MINATI, Gianfranco (Ed.): "1st Italian Conference on Systemics" - Apogeo, Milano, 1998b
- MINATI, Gianfranco: "Essere collettivi" - Apogeo, Milano, 2001a
- MINATI, Gianfranco: "The concept of emergence in systemics" - Gen. Syst. Bull., 30, 2001 b
- MINATI, Gianfranco: "Emergence and Ergodicity Research" - Proc. 2nd. Italian Syst. Conf. Kluwer, Dordrecht, 2002b
- MINATI, Gianfranco: "Ethics as emergent property of living systems" - in Encyclopedia of Life Support Systems (EOLLS) - Unesco, 2003
- MINGERS, J.C.: "Towards an appropriate social theory for applied systems thinking" - J. Appl. Syst. Anal., 7, 1980
- MINGERS, John: "The Philosophical Implications of Maturana's Cognitive Theories" - Systems Practice, 3, (6), 1990
- MINGERS, John: "Criticizing the phenomenological critique: autopoiesis and critical realism". Syst. Practice 5 (2) 1992
- MINGERS, John: "Fuenmayor's interpretive systemology: a critique" - Syst. Pract. 5, 1992
- MINGERS, John: "Questions and suggestions in using soft systems methodology" - Systemist 14, 1992
- MINGERS, John: "The problems of social autopoiesis" - I.J.G.S., 21(2), 1992
- MINGERS, John.: "Self- producing systems: implications and applications of autopoiesis" - Plenum, London, 1995
- MINGERS, J.C.: "An evaluation of theories of information with regard to the semantics and pragmatic aspects of information systems". Syst. Practice, 9 (3) 1996
- MINGERS, J. & BROCKLESBY, J.: "Multimethodology: towards a framework for critical pluralism" - Systemist, 18(3) 1996
- MINGERS, John: "A Comparison of Maturana's Autopoietic Social Theory and Giddens' Theory of Structuration". Syst. Research, 13 (4), 1996
- MINGERS, John C.: "An Evaluation of Theories of Information with regard to the Semantic and Pragmatic aspects of Information Systems". Syst. Practice 9 (3), 1996
- MINGERS, John (rev.): "Radical constructivism: a way of knowing and learning" (E. von GLASERSFELD) - C&HK, 3 (4) 1996
- MINGERS, J. & STOWELL, F.A. (Eds.): "Information Systems: An emerging discipline?" - McGraw Hill, Berkshire, 1997
- MINGERS, J. & GILL, E.(Eds.): "Multimethodology: Towards theory and practice of integrating methodologies" - Wiley, Chichester, 1997
- MINGERS, John: "Systems typologies in the light of autopoiesis" - SRBVS, 14(4) 1997
- MINGERS, John: "Information, meaning and communication: an autopoietic approach to linking the social and the individual" - C&HK., 6 (4) 1999
- MINGERS, John: "The history and development of soft systems methodology" - SPAR, 13(6) 2000
- MINGFEN, Li: "Fostering design culture through...designing thinking and systems thinking" - SPAR, 15(5) 2002
- MINSKY, M. & SELFRIDGE, O.: "Learning in random nets". 4th. London Symposium on Information theory, 1960
- MINSKY, Marvin: "Computation: Finite and infinite machines". Prentice Hall, Englewood Cliffs, 1967
- MINSKY, M. & PAPERT, S.: "Perceptrons". M.I.T., Cambridge, Mass., 1969 - Expanded edition: idem, 1988
- MINSKY, Marvin: "The Society of the Mind". Simon & Schuster, New York, 1986
- MINSKY, Marvin: "Will robots inherit the earth?" - Sc. Amer., Oct. 1994
- MIRA, J. & SANDOVAL, F. (eds.): "From natural to artificial computation" - Springer Verlag, Berlin, 1995
- MIRHAM, Danielle & Arthur: "Human knowledge: the role of models, metaphors, and analogy". Intern. J. Gen. Systems, 1 (1) 1975
- MIRHAM, Danielle & Arthur: A review of W.H. Leatherdale's book: "The role of analogy, model and metaphor in science". Intern. J. Gen. Systems, 4 (2) 1978
- MIRJAMDOTTER, A.: "A multi-modal systems extension to soft systems methodology" - University of Technology, Lulea, Sweden, 1998
- MIRITA, Ion I.: The unification of sciences in Scientia Generalis of Leibniz" - CASYS J., 6, Liège, Belgium, 2000
- MIROW, Heinz: "Kybernetik: Grundlage einer allgemeinen Theorie der Organisation". Th. Gabler GmbH, Wiesbaden, 1969

- MISHAN, E.J.: "The costs of economic growth". Pelican Books, Harmondsworth, 1967
- MISHAN, E.J.: "21 Popular economic fallacies". Pelican Books, Harmondsworth, 1969
- MISRA, B. et al.: "From deterministic dynamics to probabilistic descriptions". *Physica*, S8A, 1-26, 1979
- MISSENARD, André: "A la recherche du temps et du rythme". Pion, Paris, 1940
- MISTREE, F. & PEDERSON, K.: "On evolution and systems development" - Proceed. 42nd. ISSS Conf., Atlanta, 1998
- MITCHELL, B.: "Theory of categories". Academic Press, New York, 1965
- MITCHELL, Edgar: "Nature's mind: the quantum hologram" - CASYS J., 7, Inst.de Math., Univ. de Liège, Belgium, 2000
- MITCHELL, Melanie: "Genetic Algorithms: An Overview" - Complexity, Vol.1, Nr.1, 1995
- MITCHELL, M.: "An introduction to genetic algorithms" - MIT Press, Cambridge, MA., 1996
- MITCHE, Donald: "Introductory readings in expert systems". Gordon and Breach, New York, 1982
- MITROFF, I.I.: "Epistemology as General Systems Theory". *Phil. of Social Sciences*, 3, (p.117-34), 1973
- MITROFF, I.I. & LINSTONE, H.A.: "The unbounded mind". Oxford Univ. Press, New York, 1993
- MITTENTHAL, J.E. & BASKIN, A.B. (Eds): "Workshop on Principles of Organization in Organisms" - Addison Wesley, Reading, MA, 1992
- MODELSKI, G.: "Long Cycles in World Politics" - Macmillan, London, 1987
- MOGGRIDGE, A. & REASON, P.: "Human inquiry: steps towards emancipatory practice" - *Syst. Pract.* 9, 1996
- MOISSEEV, N.: "Problèmes mathématiques d'analyse de systèmes" - Ed. Mir, Moscou, 1985 (Original in Russian)
- MOLES, Abraham: "Théorie structurale de la communication et société" - Masson, Paris, 1986
- MONOD, Jacques: "Les frontières de la Biologie" - La Recherche, oct.1970
- MONOD, Jacques: "Le Hasard et la Nécessité" - Le Seuil, Paris, 1970 (In english: "Chance and Necessity" - A. Knopf, New York, 1971)
- MONTEIRO, E. & HEPSØ, V.: "Purity and danger of an information infrastructure" - SPAR, 1592, 2002
- MONTPELLIER (Colloque de): "Science et pratique de la complexité" - Documentation française, Paris, 1986
- MONTUORI, A.: "Evolutionary competence: creating the future" - J.C. Gieben, Amsterdam, 1989
- MORAVEC, H.: "Robot-Mere machine to transcendent mind" - Oxford Univ. Press, Oxford/New York, 1999
- MORELAND, Richard: "Lewin's legacy for small group research" - *Syst. Practice* 9 (1), 1996
- MOREN, J. & BALKENIUS, C.: "Reflections on emotion" - Proc.15th Cyb.&Syst. Meeting, Austrian Soc. for Cyb. Studies, Vienna, 2000
- MORENO DIAZ, R. & MIRA-MIRA, J.(eds.): "Brain processes, theories and models" - MIT Press, Cambridge, Mass., 1996
- MORGADO, L. & GASPAR, G.: "A social reasoning mechanism based on a new approach for coalition formation" - Proc. 15th Cybernetics & Systems Meeting, Austr.Soc.Cyb.Stud., Vienna, 2000
- MORGAN, G. (ed.): "Beyond method" - Sage, Beverly Hills, 1973
- MORGAN, G.: "Cybernetics and organization theory: Epistemology or technique?" - *Hum. Relat.*, 35 (521-37), 1975
- MORGAN, G.: "Paradigms, metaphors and puzzle solving in organization theory". *Adm. Sci. Quarterly*, 25 (4) 1980
- MORGAN, G.: "Images of organization". Sage, London, 1986. 2nd. ed., 1997
- MORIN, Edgar: "L'événement-sphinx". *Communications* nr 18. Le Seuil, Paris, 1972
- MORIN, Edgar: "Le retour de l'événement". *Communications* nr. 18, Le Seuil, Paris, 1972
- MORIN, E. & PIATELLI PALMERINI, L. (eds): "L'Unité de l'homme". Le Seuil, Paris, 1973
- MORIN, Edgar: "La Méthode" - 4 Vol. - Le Seuil, Paris, 1977-1991
- MORIN, Edgar: "Sur la définition de la complexité" en "IDATE: Science et pratique de la complexité". Documentation Française, Paris, 1984
- MORIN, Edgar: "Introduction a la pensée complexe". E.S.F., Paris, 1990
- MORIN, Edgar: "Science avec conscience" (nouvelle édition révisée) - Fayard, Paris, 1990
- MORIN, Edgar: "Method: toward a study of human kind. Vol.1: The nature of nature" - Peter Lang Publ., New York, 1992
- MORIN, Edgar: "La complexité humaine" - Flammarion, Paris, 1994
- MORIN, Edgar: "Relier les connaissances: le défi du 21^e. siècle" - Le Seuil, Paris, 1999
- MORIN, Edgar: "La tête bien faite". Le Seuil, Paris, 1999 a (Written for UNESCO and translated to various languages)
- MORIN, Edgar: "Les sept savoirs nécessaires à l'éducation du futur". UNESCO, Paris, 1999b (Written for UNESCO and translated to various languages)
- MORRIS, Charles W.: "Foundations of the theory of signs". Univ. of Chicago Press, 1938
- MORTENSEN, V. & SORESENSEN, R.C. (eds.): "Free will and determinism" - Aarhus Univ. Press, Aarhus, Denmark, 1987
- MOSEKILDE, E. & MOSEKILDE, L. (Eds): "Complexity, Chaos and Biological Evolution" - Plenum Press, New York, 1991
- MOSER, Sibylle: "Observing differences, embodying knowledge" - C&HK, 9(3-4) 2002
- MOTIL, John M.: "Digital systems fundamentals". McGraw Hill, New York, 1972
- MOULIN, Thiébaud et al. (Ed.): "Réflexions sur de nouvelles approches dans l'étude des systèmes". E.N.S.T.A., Paris, 1975
- MOULIN, Thiébaud: "Tentative de modélisation d'un système neuronal au moyen d'un relateur arithmétique", Groupe Systema, E.N.S.T.A., Paris, 1988
- MÜLLER, H.M.: "Evolution, Kognition und Sprache. Die Evolution des Menschen und die biologischen Grundlagen der Sprachfähigkeit" - P. Paray, Berlin, 1987.
- MUELLER, J.: "Grundlagen der Systematische Heuristik" - Dietz Verlag, Berlin, 1970
- MULEJ, Matias: "Discovery of the disappearing knowledge by the "Usomid" methodology" in G. de Zeeuw (ed.) "Knowledge (dis) appearance. Systeem Groep Nederland, Delft University Press, 1986
- MULEJ, Mathias et al.: "Education for innovativeness" and "Methods for creative cooperation", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- MULEJ, Mathias & REBERNIK, Miroslav (eds): "Intervention and quality". *Syst. Research*, (special issue), 11 (1) 1994
- MULEJ, Matjaz et al.: "Teaching on/for Systems Thinking" - Proc.6th IDIMT, Zadov; Universitätverlag R. Trauner, Linz, 1998
- MULEJ, Matjaz et al.: "Applied Systems thinking and the Law of Requisite Holism" - Proc.7th IDIMT, Zadov; Universitätverlag R. Trauner, Linz, 1999
- MULEJ, Matjaz et al.: "USOMID: a method supportive of the Law of Requisite Holism" - Proc.8th IDIMT, Zadov, Universitätverlag R. Trauner, Linz, 2000
- MULEJ, Matjaz & ZENKO, Zdenka: "Information and soft systems theories in the modern think and acting" - Proc. Of the 9th IDIMT, Zadov, Universitätverlag R. Trauner, Linz, 2000
- MULEJ, Matjaz et al.: "Informal systems thinking or systems theory about innovation in Slovenia" - Proc. 16th Meet. of Cyb. & Syst., Vienna, 2000
- MULEJ, Matjaz et al.: "Seven basic groups of systems thinking principles and eight basic assumptions of a General Theory of Systems" - Univ. of Maribor, Slovenia, 2002
- MULEJ, Nastja: "Marketing as informal or formal systems thinking" - Proc. 6th IDIMT Zadov, Univ.Verlag R. Trauner, Linz, 1998
- MULLER, Karl H. et al.: "Chaos 2000: das globale Zeitbeben" - Döcker Verlag, Wien, 1999
- MUMFORD, David et al.: "Indra's pearls: the vision of Felix Klein" - Cambridge University Press, Cambridge, MA 2002
- MUMFORD, Lewis: "The myth of the machine: 1. Technics and human development; II. The Pentagon of power" - Harcourt Brace, New York, 1967-1971
- MUNRO, Iain: "Man-machine systems: people and technology in operational research" - SPAR, 12 (5), 1999
- MUNTEAN, Tvaian: "Les supercalculateurs à transputers". *La Recherche*, nr 204, nov. 1988
- MURAI, T. & SATO, Y.: "Anticipation in belief formation systems based on evidence" - CASYS J., 11, Proceed. Univ. of Liège, 2002
- MURRAY, Carl: "Is the solar system stable?". *New Scientist*, November 25, 1989
- MURRAY, J.: "Information, communication and technology" - C&HK, 5(2), 1998
- MURRAY, Peter J.: "complexity theory and the fifth discipline" - SPAR, 11(3) 1998
- MURTHY, P.N.: "A systemic view of cognition; a contribution of Indian philosophic thought and tradition" - SRBVS, 15(2) 1998
- MURTHY, P.N.: "Complex societal problem solving: methodological criteria" - SRBVS, 17(1), 2000
- MUSES, Charles: "Destiny and Control in Human Systems". Kluwer Nijhoff, Boston, 1985
- MUSSER, George: "Dawn of a new species?" - *Sc.Amer.*, nov. 2000

- MWALUKO, G.S. & RYAN, T.B.: "The systemic nature of action learning programmes"- SRBVS, 17(4)2000
- MYHILL, John: "The abstract theory of self reproduction", in Mesarovic, M. (ed.): "Views on General Systems Theory". R. Krieger, New York, 1963
- NADLER, Gerald: "Work system design: The ideal concept". Irwin, Homewood, Ill., 1967 (French transl.: "La conception des systèmes". Vander, Leuven, Belgium, 1973)
- NADLER, G.: "The planning and design approach" - Wiley, New York, 1981
- NADLER, G. & HIBINO, S.: "Breakthrough thinking" - Prima Publ., Rocklin CA, 1990
- NAGEL, T.: "The view from nowhere" - Oxford Univ. Press, New York, 1986
- NALIMOV, Vassily V.: "In the labyrinths of language: a mathematician's journey"- ISI Press, Philadelphia, PA, 1981a
- NALIMOV, Vassily V.: "Facts of Science"- ISI Press, Philadelphia, PA, 1981b
- NALIMOV, Vassily V.: "Realms of the unconscious: the enchanted frontier"- ISI Press, Philadelphia, PA, 1982
- NALIMOV, Vassily V.: "Space, time and life: the probabilistic pathways of evolution"- ISI Press, Philadelphia, PA, 1985
- NAROLL, R. & BERTALANFFY, L. von: "The principle of allometry in Biology and the Social Sciences". SGRS Yearbook, 1, 1956
- NATKE, H.G.: "Models and reality in systems dynamics"- Unser Verlag OHG, Hannover, 2000
- NEEDHAM, Joseph: "Order and Life" - Yale Univ. Press, 1936 - (2nd ed., MIT Press, Cambridge MA, 1968)
- NEEDHAM, Joseph: "Integrative Levels" - Oxford Univ. Press, 1937
- NEGOITA, Constantin V.: "Fuzzy systems". Abacus, Tunbridge Wells, 1978
- NEGOITA, Constantin V.: A review of Klir, G. & Folger, T.: "Fuzzy sets, uncertainty and information". Syst. Research, 5 (4) 1988
- NEGOITA, Constantin V. (ed): "Cybernetics and applied systems". M. Dekker, New York, 1992
- NEGROTTI, Massimo: "Per una teoria dell'artificiale"- Prometheus series, Franco Angeli, Milano, 1993
- NEGROTTI, Massimo: "Towards a theory of the artificial"- C&HK, 2(2) 1993
- NEGROTTI, Massimo (ed.): "Artificialia; la dimensione artificiale della natura humana" - CLUEB, Bologna, 1995
- NEGROTTI, Massimo: "The nature of the artificial"- World Scientific, London, 2002
- NEIRYNCK, Jacques: "Le huitième jour de la création" - Presses Polytechniques et Universitaires Romandes, Lausanne, 1990
- NEISSER, U.: "Cognition and reality". Freeman, San Francisco, 1976
- NELSON, P.: "Logique des neurones et du système nerveux". Maloine Doin, Paris, 1978
- NEUMAN, John von & MORGENTHAU, Oscar: "Theory of games and economic behavior". 3rd ed., Princeton Univ. Press, 1964
- NEUMAN, Yair: "A difference that makes a difference: on artifact-mediated-consciousness" - C&HK(4), 1999
- NEUMAN, Y. & BEKERMANN, Z.: "Where a blind man ends: five comments on context, artifacts and the boundaries of the mind"- SRBVS, 17(3) 2000
- NEUMAN, Yair: Existing as "A difference that makes a difference": on Cybernetics, Semiotics and Being"- C&HK, 8(3) 2001
- NEUMAN, Yair: "On Turing's carnal error: guidelines for a contextual inquiry into the embodied mind"- SRBVS, 18(6) 2001
- NEUMANN, John von: "The general and logical theory of automata". Simon & Schuster, New York, 1956
- NEUMANN, John von: "Probabilistic logics and the synthesis of reliable organisms from unreliable components". Automata Studies, Princeton, 1956
- NEUMANN, John von: "The computer and the brain". Yale Univ. Press, 1958
- NEUMANN, John von: "Theory of self reproducing automata". Univ. of Illinois Press, Urbana, Ill., 1966
- NEUMANN, J von: "Letter to Norbert Wiener on Cybernetics" (1946). Kybernetes, 21 (5) 1992
- NEURATH, P.: "From Malthus to the Club of Rome and back" - M.E. Sharpe, Armonk, N.Y., 1994
- NEWELL, A. & SIMON, H.A.: "Computer simulation of human thinking". Science, 134 (p.2011-7), 1961
- NEWELL, A. & SIMON, H.A.: "Human problem solving". Prentice Hall, Englewood Cliffs, 1972
- NEWELL, A.: "Unified theories of cognition" - Harvard Univ. Press, Cambridge, Mass., 1990
- NEWTON, N.: "Foundations of understanding" - J. Benjamin, Amsterdam, 1996
- NICOLAU, Edmond: "Cybernetics: the Bridge between divided Knowledge and Transdisciplinarity". Kybernetes, 24 (7) 1995
- NICOLAU, E. & POPOVICI, A.: "Introducere in Cibernetica Sistemelor Discrete". Edit. Tehnica, Bucuresti, 1966 (in Rumanian)
- NICOLAU, Edmond: "Modelarea în Stiință". Edit. Stiintifica si Enciclopedica, Bucuresti, 1981 (in Rumanian)
- NICOLESCU, Basarab: "Science, meaning and evolution" - Parabola, New York, 1991
- NICOLESCU, Basarab: "La Transdisciplinarité: Manifeste" Editions du Rocher, Monaco, 1996
- NICOLESCU, Basarab: "La Transdisciplinarité"- Ed. Du Rocher, Paris, 1997
- NICOLESCU, Basarab: "Stephan Lupasco: l'homme et l'oeuvre" - Editions du Rocher, Monaco, 1999
- NICOLIS, G. & PRIGOGINE, I.: "Self organization in non equilibrium systems". J. Wiley, New York, 1977
- NICOLIS, G. & PRIGOGINE, I.: "Nonequilibrium phase transitions: from physics and chemistry to biology". Center Stat. Mech. & Therm., Univ. of Texas, Austin, 1978
- NICOLIS, Gregoire: "Bifurcations, fluctuations and dissipative structures", in Enns, R. et al. (Eds.): "Non linear phenomena in physics and biology". Plenum Press, New York, 1981
- NICOLIS, G. et al.(eds.): "Order and fluctuations in equilibrium and non-equilibrium statistical mechanics" - Wiley, New York, 1981
- NICOLIS, Gregoire: "L'écart à l'équilibre, source de comportements complexes de la matière". Nouvelles de la science et des technologies, 2 (1/2) 1984
- NICOLIS, G. & PRIGOGINE, I.: "Exploring Complexity". Freeman, New York, 1989
- NICOLIS, J.S. et al.: "Communication between two self-organizing systems modelled by controlled Markov chaos". Univ. of Patras, Greece, 1977
- NIEH, James C.: "Stingless-Bee Communication" - Amer. Sc., Vol.87 (5), Sept.-Oct. 1999
- NIEN-TSU TWAN & RYAN, T.: "Toward a humanized systemic organization: a Confucian perspective"- SRBVS, 17(4), 2000
- NIEN-TSU TWAN & RYAN, T.: "Is the wind or the flag moving? An oriental perspective on the complex problem" - SRBVS, 19(3) 2002
- NIEUWENHUIJZE, Otto van: "S.T.E.C.: Space-Time-Energy-Consciousness: the paradox in model making" - CASYS J., 7, Inst. de Math., Univ. de Liège, 2000
- NIJLAND, Geert O.: "The tetrahedron of knowledge acquisition: a meta-model...in the research on socio-ecological systems" - SRBVS, 19(3) 2002
- NISSEN, H.E., KLEIN, H. & HIRSCHHEIM, R.(Eds.): "Information Systems Research: Contemporary Approaches and Emergent Traditions" - North Holland, Amsterdam, 1991
- NOBIS, Adam: "Culture: from system to self-organizational interaction" - Systems, 2(1), Techn. Univ. Wroclaw, Poland, 1997
- NOHRIA, N. & ECCLES, R.G. (eds.): "Networks and organizations: structure, form and action" - Harvard Business School Press, Boston, MA, 1992
- NOLFI, S. & FLOREANO, D.: "Evolutionary robotics; the biology, intelligence and technology of self-organizing machines" - MIT Press, Cambridge, 2000
- NORMAN, M.F.: "Markov processes and learning models". Academic Press, New York, 1972
- NORMILE, Dennis: "Exploring the Systems of Life"- Science, Vol. 284, Nr.5411, p. 80-81
- NORUM, Karen: "Appreciative design"- SRBVS, 18(4)2001
- NOTH, W.: "Handbook of Semiotics"- Indiana Univ. Press, Bloomington, Indianapolis, 1995
- NOTH, Winfried: "Handbuch der Semiotik " 2nd. revised and extended edition - Metzler, Stuttgart, 2000
- NOTH, Winfried: "Biosemiotica" (a review) - C&HK., 8 (1-1), 2001
- NOTH, W.: "Semiosis and the Umwelt of a robot"- Semiotica, 134, 2001
- NOTH, W.: "Semiotic machines"- C&HK, 9(1) 2002
- NOTTALE, Laurent: "Fractal space-time and microphysics" - World Scientific, Singapore, 1993
- NOWAKOWSKA, Maria: "Language of motivation and language of action"- Mouton, The Hague, 1973
- NOWAKOWSKA, Maria: "Basic structural properties of knowledge and observations". in G. de Zeeuw (ed.): "Knowledge (dis)appearance". Systeem Groep Nederland, Delft, 1986
- NOWAKOWSKA, Maria: Review of Dascal, M.: "Leibniz, language, signs and thoughts". Syst. Research, 5 (4) 1988
- NUÑEZ, R. & FREEMAN, W.J.: "Reclaiming cognition" - Imprint Academic, Bowling Green, OH, 1999
- NUMMELIN, E.: "General irreducible Markov chains and non negative operators" - Cambridge Univ. Press, 1984
- NURMI, H.: "Causality and complexity". Turun Yliopisto, Turku, Finland, 1974
- NUSSE, H. & YORKE, J.: "Dynamics: numeral explorations" - Springer, New York, 1998

- NYHOLM, R.S.: "The shape of inorganic molecules" – Science News 20, Penguin Books, Harmondsworth, 1951
- NØRRENTANDERS, Tor: "The user illusion: Cutting consciousness down to size" – Penguin Books, New York, 1999
- O'NEILL, J.: "On critical theory" – The Seabury Press, New York, 1976
- O'NEILL, R.V. et al. "A hierarchical concept of ecosystems" – Princeton University Press, Princeton, N.J., 1985
- OBERMEIER, Otto Pieter: "Zweck, Funktion, System. Untersuchung zu Niklas Luhmanns Theoriekonzeptionen" – Alber, Freiburg, München, 1988
- ODOBLEJA, Stephan: "Psihologia consonantista si Cibernetica". ("Consonance Psychology and Cybernetics"), in Rumanian, Scrisul Românesc, Craiova, Rumania, 1978
- ODOBLEJA, Stephan: "Cybernétique Générale: Psychologie consonantiste". Maloine, Paris, 1938. (Reprinted by Edit. Nagard, Montreal, Paris, Pelham, New York, 1983)
- ODOBLEJA, Stephan: "Introducere in logica resonantei". ("Introduction to resonance logic"), in Rumanian, Scrisul Românesc, Craiova, Rumania, 1984
- ODUM, Eugene: "Fundamentals of Ecology". W.B. Saunders, 1971
- ODUM, Eugene P.: "Ecology: A bridge between Science and Society" – Sinauer Assoc. Inc. Publishers, Mass., 1997
- ODUM, H.T. & PINKERTON, R.C.: "Time's speed regulator: the optimum efficiency for maximum power output in physical and biological systems". Amer. Scientist, 43, 1955
- ODUM, Howard T.: "Environment, Power and society". J. Wiley, New York, 1971
- ODUM, Howard T. & ODUM, Elizabeth C.: "Energy basis for man and nature". McGraw Hill, New York, 1976
- ODUM, Howard T.: "Systems ecology: An introduction". Wiley, New York, 1983
- ODUM, H.T. & SCIENECMAN, D.: "Commonalities between hierarchies of ecosystems and political institutions" – General Systems, XXIX, 1985-86, p. 23-32
- ODUM, Howard T.: "Self organization, transformity and information". Science, 242, 1988
- ODUM, Howard T.: "Emergy and biochemical cycles", in Rossi & Tiezzi (eds): "Ecological Physical Chemistry". Elsevier Science Publ., Amsterdam, 1991
- ODUM, H.T. & CAMPBELL, D.E.: "Appreciative inquiry: a mechanism for maximizing empower in social systems" – Proc. 42nd ISSS Meet., Atlanta, 1998
- ODUM, Howard T.: "Emergy hierarchy of the earth" – Proc. 42nd ISSS Conf., Atlanta, 1998
- ODUM, Howard T.: "Limits to memory in ecosystems and society" – Proc. 42nd ISSS Conf., Atlanta, 1998
- ÖREN, Tuncer: "Simulation models: Taxonomy", in M. G. SINGH (ed): "System and Control Encyclopedia". Pergamon, Oxford, 1987
- ÖREN, Tuncer: "A paradigm for artificial intelligence in software engineering", in Ören, T. (ed): "Advances in artificial intelligence in software engineering". J.A.I. Press, 1990
- OESER, E.: "Das Abenteuer der kollektiven Vernunft" – P. Parey, Berlin, 1988
- OFFNER, Franklin: "Limitations on complexity of random learning networks". Biophysical J., 5, 1965
- OJEDA BENITEZ, Sara (Ed): "Hacia una Visión sistémica: Diversas aplicaciones". Universidad Autonoma de Baja California, Mexicali, Mexico, 1995
- O'KEEFE, J. & NADEL, L.: "The hippocampus as a cognitive map" – Oxford, Clarendon Press, 1978
- OLDERSHAW, R.L.: "Conceptual foundations of the self-similar hierarchical cosmology" – IJGS, 7, 1981, p. 151-157
- OLIGA, J.: "Methodological foundations of systems methodologies" – Syst.Pract. v.1, 1987
- OLIGA, J.: "La ideologia y la emancipación de los sistemas" – Sistémica, Vol.2, Nr.2, Lima, 1991
- OLIGA, J.: "Power, ideology and control" – Plenum, New York, 1996
- OLIVETTI BELARDINELLI, M.: "La costruzione della realtà como problema psicologico" – (3ed.) Boringhieri, Torino, 1987
- OLIVETTI BELARDINELLI, M.: "Processi ritmici nell'elaborazione cognitiva" – ESI, Napoli, 1993
- OLIVETTI BELARDINELLI, M.: "Cognitive systems architectures: toward an integration of perspectives" – 1st. Italian conf. on Systemics" – Apogeo, Milano, 1998
- ONG, W.J.: "Interfaces of the world: studies in the evolution of culture and consciousness" – Cornell Univ. Press, Ithaca, 1977
- ONSAGER, L.: "Reciprocal relations in irreversible processes". Phys. Review, 37, 1931
- ORCHARD, Robert A.: "On the laws of form". Intern J. Gen. Systems, 2 (2) 1975
- ORLOVE, Benjamin et al.: "Ethnoclimatology in the Andes" – Amer.Sci., 90(5) sept.-oct. 2002
- ORMAN QUINE, Williard van: "The scope and language of science" – Brit.J. Phil. Sc., 8 (29), May 1957
- ORMAN QUINE, Williard van: "Word and object" – MIT Press, Cambridge, MA, 1960
- ORMAN QUINE, Williard van: "The Ways of Paradox" – Random House, New York, 1966
- ORMAN QUINE, Williard van: "Ontological Relativity and other essays" – Columbia Univ. Press, New York, 1969
- ORMAN QUINE, Williard van: "Methods of Logic" – Holt, Rhinehart and Winston, New York, 1972
- ORMAN QUINE, Williard van: "The roots of reference" – La Salle, Ill., 1974
- ORT, Nina & PETER, Markus: "N. Luhmann: sign as form" – A comment. – C&HK, 6 (3), 1999
- ORT, Nina: "Searching for the limits of semiotics: an extended manual for an extended scientific field" – C&HK., 8, (1-2), 2001
- ORTEGA Y GASSET, José: "The revolt of the masses". W.W.Norton & Co., New York, 1932 (Original in Spanish)
- ORTEGA Y GASSET, José: "Meditación de la técnica" – Revista de Occidente, Madrid, 1977(1st. ed. 1939)
- ORTEGA Y GASSET, José: "Kant, Hegel, Dilthey" – 3ra. ed. (in spanish). Ed. Revista de Occidente, Madrid, 1965
- ORTEGON-MONROY, Maria Carolina: "Chaos and Complexity Theory: A review of its status, perspectives and implications for management" – Working paper Nr.36, Fac. of Business and Management, Univ. of Lincolnshire & Humberside, Oct. 1999
- ORTONY, Andrew (ed.): "Metaphor and thought" – Cambridge University Press, Cambridge, 1979
- OSHRY, Barry: "Seeing systems: unlocking the mysteries of organizational life" – Berrett Koehler, San Francisco, 1996
- OSSIMITZ, Günther: "Entwicklung vernetzen Denkens (Endbericht)" – Univ. Klagenfurt, 1996
- OSSIMITZ, Günther: "Systemdynamik Software und Mathematikunterricht (Endbericht)" Univ. Klagenfurt, 1996
- OSSIMITZ, Günther: "The development of systems thinking skills using System Dynamics tools" – Univ. Klagenfurt, 1997
- OSSIMITZ, Günther: "Conflict-solving as a process: the conflict theory of Gerhard Schwarz" – Proceed.10th Fuschl Conversations, Linz University, 2000
- OTT, Edward et al.: "Controlling chaos". Phys. Rev. Lett., 64, 1196, 1990
- OTT, E.: "Chaos in dynamical systems" – Cambridge University Press, 1993
- OTT, E. & SPANO, M.: "Controlling chaos". Phys. Today, May 1995
- OTT, J.S.: "The organizational culture perspective" – Brooks-Cole, Pacific Grove, 1989
- OYAMA, S.: "The ontogeny of information: developmental systems and evolution" – Cambridge Univ. Press, 1985
- OYAMA, S. & GRIFFITHS, P.E.: "Cycles of contingency" – MIT Press, Cambridge, MA, 2000
- OZBEKHAN, Hassan: "Planning and human action", in Weiss, P. (ed): "Hierarchically organized systems in theory and practice". Haffner, New York, 1971
- OZBEKHAN, Hassan: "The emerging methodology of planning". Fields within fields, nr. 10, 1973-74
- OZINGA, James R.: "Altruism" – Praeger, New York, 1999
- PACEY, A.: "The culture of technology" – MIT Press, Cambridge, MA, 2000
- PACKER, M.J. & ADDISON, R.B. (eds.): "Entering the circle: Hermeneutic investigation in psychology" – State Univ. New York Press, Albany, 1989
- PADULO, Louis & ARBIB, Michael: "Systems theory: A unified state space approach to continuous and discrete systems". Saunders, Philadelphia, 1973
- PAETAU, Michael: "Can virtual enterprises built up an own identity?" – C&HK, 6(2) 1999
- PAGELS, Heinz: "The Dreams of Reason: The computer and the Rise of the Science of Complexity" – Simon & Schuster, New York, 1988
- PAHL-WOSTL, Cl.: "The Dynamic Nature of Ecosystems: Chaos and Order Entwined" – Wiley, London, 1999
- PAKMAN, Marcelo: "Disciplinary knowledge; post-modernism and globalization (in health professions)" – C&HK, 7(2-3), 2000
- PAKMAN, Marcelo: "Reflective practices: the legacy of Donald Schön" – C&HK, 7(2-3) 2000
- PALOMBA, Giuseppe: "L'espansione capitalistica" – Gianini, Napoli, 1968/UTET, Torino, 1973
- PANKOW, Walter: "Openness as self-transcendence", in Jantsch, E. & Waddington, C. (eds): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1976
- PANTZAR, M.: "The evolutionary paradigm and neo-classical economics" – In Laszlo (1991) p. 157-178

- PAPADIMITRIOU, C.H.: "Computational complexity" - Addison Wesley, Reading, Mass., 1994
- PARADISOPOULOS, Iordanis K.: "Cybernetic model of the railway enterprise". *Cyb. & Systems*, 23 (1) 1992
- PARITSIS, Nicos: "Towards a law of optimum variety". *Cybernetics & Systems Research* 92, World Scientific, Singapore, 1982
- PARITSIS, Nicos: "Evolution learning and progress of science: an increase in variety and order". *Syst. Research*, 10 (4) 1993
- PARITSIS, Nicholas: "Sociocultural systems design based on collective intelligence functions"- *Cybernetica*, XL (4), 1997
- PARITSIS, Nicholas: "Troposes: their functions and their possible contribution in changing human behavior"- 10th Fuschl Conversations, 2000
- PARKS, P.W. & THRIFT, N.J.: "Times, spaces and places: A chrono-geographic perspective". Wiley, New York, 1980
- PARRA, C. & YANO, M.: "Tridimensional recursive learning model"- *C&HK*, 9(3-4) 2002
- PARRA LUNA, Francisco: "Controlling social systems: an introduction to 3rd. cybernetics", in Banathy, B. & Rodríguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Publ., Madrid, 1993
- PARRA-LUNA, Francisco: "Hacia la tercera cibernética: una introducción"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- PARRA-LUNA, Francisco (ed.): "The performance of social systems: perspectives and problems" - Kluwer, New York, 2000
- PARRA-LUNA, Francisco: "An axiological systems theory: some basic hypotheses"- *SRBVS*, 18(6) 2001
- PARRISH, Julia & EDELSTEIN-KESHET, Leah: "Complexity, Pattern and Evolutionary Trade-Offs in Animal Aggregation" - *Science*, Vol. 284, April 2, 1999, p. 99-101
- PARSONS, Talcott: "The social system". Free Press, Glencoe, 1951
- PARSONS, T.: "Toward a general theory of action" - Cambridge, 1951
- PARSONS, T.: "Social systems and the evolution of action theory" - The Free Press, New York, 1977 (orig. work publ. 1968)
- PARSONS, Talcott: "The system of modern societies". Prentice Hall, Englewood Cliffs, 1972
- PARSONS, Talcott: "Concrete systems and "abstracted systems". *Behav. Science* 25 (1) 1980
- PARTHASARATHY, Hemai: "Mind Rhythms" - *N.Sc.* Nr.2210, October 30th, 1999
- PARTRIDGE, B.L.: "The Structure and Function of Fish Schools" - *Sc. Amer.*, 246 (6), p.114-23
- PASK, Gordon: "The growth process inside the cybernetic machine". 2nd. Intern. Conf. on Cybernetics, Namur, 1958
- PASK, Gordon: "Organic control and the cybernetic method". *Cybernetica*, 1 (3) 1958
- PASK, Gordon: "The natural history of networks", in Yovitz, M.C. & Cameron, S (eds): "Self-organizing systems". Pergamon, New York, 1960
- PASK, Gordon & von FOERSTER, Heinz: "A predictive model for self-organizing systems". *Cybernetica*, 3 (4), 1960; 4 (1), 1961
- PASK, Gordon: "An approach to cybernetics". Hutchinson, London, 1961a
- PASK, Gordon: "The cybernetics of evolutionary process and of self-organizing systems". 3rd. Intern. Conf. on Cybernetics Namur, 1961b
- PASK, Gordon: "The self-organising system of a decision making group". *Proc. 3rd Congr. of Cybernetics*, Namur, Belgium, 1961c
- PASK, Gordon: "The use of analogy and parable in Cybernetics with emphasis upon analogies for learning and creativity". *Dialectica*, 17, 1963
- PASK, Gordon: "The meaning of cybernetics in the behavioral sciences", in Rose, J. (ed): "Progress of cybernetics" V.1 Gordon & Breach, New York, 1969
- PASK, Gordon: "Guide to a new point of view". *ASC Cyb. Forum*, IV (3) 1972
- PASK, Gordon & SCOTT, B.C.E.: "CASTE: A system for exhibiting learning strategies and regulating uncertainty". *Inter. J. Man Machine Studies*, 5, (p.17-52), 1973 Note: For a quite complete bibliography of G. Pask, see *Syst. Research*, V.10, nr.3, 1993 (G. PASK Festschrift)
- PASK, Gordon: "Letter to the editor". *ASC Cyb. Forum*, V (4) 1973
- PASK, Gordon: "Conversation, Cognition and Learning". Elsevier, Amsterdam, New York, 1975
- PASK, Gordon: "The cybernetics of human learning and performance". Hutchinson, London, 1975
- PASK, Gordon: "Conversation theory: Applications to education and epistemology". Elsevier, Amsterdam, New York, 1976
- PASK, Gordon: "Organizational closure of potentially conscious systems". *NATO Conf. on appl. Gen. Syst. Res.*, 1977
- PASK, Gordon: "The generality of problem solving". *Open Univ.*, Milton Keynes, 1977
- PASK, Gordon: "Consciousness". *J. of Cybernetics*, 9 (3) 1979
- PASK, Gordon: "H. von FOERSTER's self organization, the progenitor of conversation and interaction theories" - *Syst. Res.*, 13(3), 1996
- PASLAK, Rainer: "Urgeschichte der Selbstorganisation" - Vieweg, Braunschweig, 1991
- PASSET, René: "L'économie et le vivant". Payot, Paris, 1979
- PASSET, René: "L'illusion néo-libérale" - Champs 491, Flammarion, Paris, 2000
- PASSMORE, John: "Responsability for nature: Ecological Problems and Western Traditions" - Scribner, New York, 1974
- PATON, Graham: "Information systems" as intellectual construct; its only valid form"- *SRBVS*, 14(1) 1997
- PATON, Graham: "Information System, as Intellectual Construct" - *Syst. Res. & Behav. Science*, 14 (10), 1997
- PATON, Graham: "A systemic action learning cycle as the key element of an ongoing spiral of analysis"- *SPAR*, 14 (1) 2001
- PATON, Ray: "Metaphors, models and bioinformation" - *Biosystems*, 38, 1996
- PATON, Ray: "The ecologies of hereditary information" - *C&HK*, 5 (4), 1998
- PATON, Ray C.: "Collections, systems and mathematical metaphors" - *CASYS J.*, 6, Inst. de Math., Univ. de Liège, 2000
- PATTEE, Howard (ed): "Natural automata and useful simulations". Spartan Books, Washington, 1966
- PATTEE, Howard (ed): "Biological hierarchies: Their origin and dynamics". Gordon & Breach, 1971
- PATTEE, Howard: "Physical theories of biological coordination". *Quart. Rev. of Biophysics*, nr.4, 1971
- PATTEE, Howard: "The evolution of self-simplifying systems", in Laszlo, E.(ed.): "The relevance of G.S. Theory". Braziller, New York, 1972
- PATTEE, Howard: "Hierarchy theory: the challenge of complex systems". Braziller, New York, 1973
- PATTEE, Howard: "Dynamic and linguistic modes of complex systems". *Intern. J. Gen. Systems*, 3 (4) 1977
- PATTEE, Howard: "The complementary principle in biological and social structure". *J. Soc. Biol. Struct.*, 1, p.191-200, 1978
- PATTEE, Howard H.: "Cell psychology: an evolutionary approach to the symbol-matter problem" - *Cognition and Brain Theory*, V.5 (4), 1982
- PATTEN, B.C.: "An introduction to the cybernetics of the ecosystem". *Ecology*, 40, 1959
- PATTEN, B.C. & AUBLE, G.T.: "Systems approach to the concept of niche". *Synthese*, 43, 1980
- PATTEN, B.C. & ODUM, E.P.: "The cybernetic nature of ecosystems". *Amer. Naturalist*, 118 (p. 886-95), 1981
- ***: "Patterns of Change: Learning, Diffusion, Transition" - A special issue of *Rev. intern. de Systématique* (10, 3), 1996 With eight papers on this topic.
- PATY, Michel: "Prigogine: Une philosophie de la science des métamorphoses". *Scientia*, 117 (1-4) 1982
- PAULI, W.: "Naturwissenschaftliche und erkenntnistheoretische Aspekte der Ideen von Unbewussten" - *Dialectica*, 8 (4), 1954
- PAULRÉ, Bernard (ed.): "Perspectives systémiques" - L'interdisciplinaire, Limonest (France), 1995
- PAYNE, Stephen L.: "Interdisciplinarity: potentials and challenges" - *SPAR*, 12 (2) 1999
- PAYNTER, H.M.: "Amplification and control technology", in Milsum, J. (ed): "Positive feedback". Pergamon, New York, 1968
- PEARCE, B.: "Communication and the human condition"- South Illinois Univ. Press, Carbondale, IL, 1989
- PEARCE, David W.: "Environmental Economics" - Longmans, London, 1976
- PEARL, J.: "Fusion, propagation and structuring in belief networks" - *Artificial Intelligence*, 29, 1986
- PEAT, F. David: "Synchronicity: the bridge between matter and mind". Bantam Books, New York, 1987
- PECHOUCEK, Michael et al.: "Sharing responsibility in workflow management in multi-agent systems" - *Proc. 15th Cyb. & Syst.Meet.*, Austrian Soc. for Cyb. Studies, Vienna, 2000
- PEDRETTI, A. & ZEEUW, G. de: "Problems of levels and boundaries" - Princelet, London, 1983
- PEGUIRON, Nicolas: "La systémique: une nouvelle épistémologie?". *Inst. de la Méthode, Symp. écrit* nr.1, Bienne, oct.1989
- PEGUIRON, Nicolas: "La pensée Gonsethienne et le mouvement systémique". *Inst. de la Méthode, Symp. écrit*, nr.3, Bienne, août 1990
- PEGUIRON, Nicolas: "Autonomie et hétéronomie: un modèle". *Inst. de la Méthode, Symp. écrit*, nr.5, févr. 1991

- PEIRCE, Charles S.: "Collected papers of Charles Sanders Peirce" (Eds: C. Hartshorne & P. Weiss) - Harvard U.P., Cambridge, Mass, 1931-35
- PEIRCE, Charles S.: "Collected papers" - V.1-8, Harvard Univ. Press, Cambridge, Mass., 1998
- PEIRCE, Charles S.: "A collection of essays on his work" - C&HK, 8,(1-2), 2001
- PEIRCE, J.R.: "Symbols, signals and noise: The nature and process of communication". Harper Bros, New York, 1961
- PEITGEN, H.O. & RICHTER, P.H.: "The Beauty of Fractals. Images of Complex Dynamic Systems" - Springer, Berlin, 1986
- PEITGEN, H.O. et al.: "Chaos and fractals" - Springer, Berlin, 1992
- PENMAN, Sheldon: "What are genes, anyway?" - Amer. Sci. 89 (1), Jan. 2001
- PENNA, M.P.: "The need for a systemic approach in studying Man-Machines Interfaces" - 1st. Italian Conf. on Systemics, Apogeo, Milano, 1998
- PENNISI, Elizabeth: "Unraveling Bacteria's Dependable Homing System" - Science, Vol.284, Nr.5411, p.82
- PENROSE, L.S.: "Mechanisms of self-reproduction". Annals Hum. Genetics, 23, 1958
- PENROSE, L.S.: "Self-reproducing machines"- Sc. Amer., Nr.200, 1959
- PENROSE, L.S.: "Developments in the theory of self-replication". New Biology, 21, Penguin, Harmondsworth, 1960
- PENROSE, Roger: "The emperor's new mind". Oxford Univ. Press, 1989
- PENROSE, Roger: "Shadows of the Mind". Oxford Univ. Press, New York, 1994
- PENROSE, Roger et al.: "Les deux infinis et l'esprit humain" - Flammarion, Paris, 1999 (original in English)
- PEREZ-RIOJA, J.A.: "Diccionario de símbolos y mitos"- Tecnos, Madrid, 2000
- PERKINS, D.N.: "Knowledge as design" - L. Erlbaum, Hillsdale, N.J., 1986
- PERSONNAZ, L. et al.: "Les machines neuronales". La Recherche, nr. 204, nov. 1988
- PERT, Candace: "The chemical communicators", in Bill Moyers: "Healing and the Mind"- Doubleday, New York, 1993
- PERT, Candace: "Molecules of emotion" - Scribner, New York, 1997
- PESCHE, Mark: "Toy story" - The Sciences, Sept.-Oct. 2000 (on Rodney Brooks self-learning automata)
- PESSA, Eliano: "Cognitive psychology and dynamical systems theory". Cyb. & Systems, 23 (3-4) 1992
- PESSA, E.: "Intelligenza artificiale: teoria e sistemi" - Boringhieri, Torino, 1992
- PESSA, E.: "Emergence, self-organization and quantum theory"- 1st. Italian Conf. on Systemics - Apogeo, Milano, 1998
- PESSA, E. & PENNA, M.P.: "Manuale di scienze cognitive"- Laterza, Roma, 2000
- PETERS, Arno: "Die Synchronoptische Weltgeschichte"- <http://www.zweitauseins.de/>
- PETERS, E.E.: "Fractal market analysis" - Wiley, New York, 1994
- PETERS, R.H.: "The ecological implications of body size"- Cambridge Univ. Press, Cambridge, 1983
- PETERS, R.H.: "A critique for ecology"- Cambridge Univ. Press, Cambridge, 1991
- PETITOT, Jean: "Morphogénèse du sens: pour un schématisme de la structure" - Presses Univ. de France, Paris, 1985
- PETRELLA, Ricardo: Preface to "Evaluation des choix technologiques". Technologies de l'information, 5, Namur, Belgium, 1993
- PETRI, Herbert & MISKIN, Mortimer: "Behaviorism, cognitivism and the neuropsychology of memory". Amer. Scientist, 82 (1) 1994
- PETTERSSON, M.: "Complexity and Evolution" - Cambridge Univ. Press, New York, 1996
- PEURSEN, C.A. et al.: "Informatie: Een interdisciplinaire studie". Spektrum, Utrecht, 1968 (in Dutch)
- PFEIFFER, R. et al.: "Proceedings of the 5th International Conference on Simulation of adaptive behavior" - MIT Press, Cambridge, MA, 1998
- PFEIFFER, R. & SCHEIER, C.: "Understanding intelligence" - MIT Press, Cambridge, MA, 2001
- PHALET, A.: "Philosophy and computational approach to intelligent behavior", in G. Lasker (ed): "Adv. in Syst. Research and Cybernetics". Univ. of Windsor, Ontario, Canada, 1988
- PHELAN, Steven E.: "Correspondence between complexity and systems theory"- SPAR, 12(3) 1999
- PHILLIPS, D.C.: "Holistic thought in social science"- Stanford Univ. Press, 1976
- PIAGET, Jean: "Psychology of Intelligence"- Harcourt, Brace, and World, New York, 1950
- PIAGET, Jean: "La construction du réel chez l'enfant". Delachaux et Niestlé, Neuchâtel, 1963
- PIAGET, Jean: "Biologie et connaissance". Gallimard, Paris, 1967
- PIAGET, Jean: "The stages of the intellectual development in the child", in Wason, P.C. & Johnson-Laird, P.N. (eds): "Thinking and reasoning". Penguin Books, Harmondsworth, U.K., 1968a
- PIAGET, Jean: "Le structuralisme". "Que sais-je? nr. 1311", P.U.F., Paris, 1968b
- PIAGET, Jean: "Structuralism". Harper & Row, New York, 1970 (French original, P.U.F., Paris, 1968)
- PIAGET, Jean: "L'epistemologie génétique". "Que sais-je? nr. 1399", P.U.F., Paris, 1970a
- PIAGET, Jean: "The development of object concept", in Dowdell, D.C. (ed.): "Perceptual learning and adaptation". Penguin Books, Harmondsworth, U.K., 1970b
- PIAGET, Jean: "Genetic epistemology"- Columbia Univ. Press, New York, 1970
- PIAGET, Jean: "The principles of genetic epistemology"- Routledge and Kegan Paul, London, 1972
- PIAGET, Jean: "L'équilibration des structures cognitives"- Presses Univ. de France, Paris, 1975
- PIAGET, Jean: "Psychology and Epistemology: towards a theory of knowledge" - Penguin, Harmondsworth, Middlesex, 1977
- PIATELLI, M. & BIANCHI, N.: "On sustainability and simulation: an approach oriented to social groups" - 1st. Italian Conf. on Systemics. Apogeo, Milano, 1998
- PIATELLI-PALMARINI, M. (ed): "Théories du langage, Théories de l'apprentissage" (The Chomsky-Piaget Debate with numerous participants). Le Seuil, Paris, 1979
- PIATELLI-PALMARINI, M. (ed.): "Language and learning; the J. Piaget-N. Chomsky Debate" - Harvard University Press, Cambridge, Mass., 1980
- PICHLER, Franz: "Mathematische Systemtheorie"- de Gruyter, Berlin-New York, 1975
- PICHLER, Franz: "On the construction of Koestler's holarchical networks".- Proc. 15th Cyb. & Syst. Meet., Austrian Soc. Cyb. Stud., Vienna, 2000
- PICKET, S. & WHITE, P. (eds): "The ecology of natural disturbance and patch dynamics". Academic Press, New York, 1985
- PIETSCHMANN, H.: "Phänomenologie der Naturwissenschaft" - Springer Verlag, Jmuiden, Netherlands, 1996
- PILLET, Gonzague et ODUM, Howard: "Energie, écologie, économie" - Georg, Genève, 1987
- PIMENTEL, David: "America's agricultural future". The Economist, Sept.8, 1977
- PIMENTEL, David: "Food, energy and society" - Cornell University, Ithaca, 1990
- PINCHOT, Gifford & Elizabeth: "The end of bureaucracy and the rise of the intelligent organization". Berret-Koehler, San Francisco, 1993
- PINES, David (Ed.): "Emerging Syntheses in Science". Addison Wesley, Reading Massachusetts, 1988
- PINKER, S. & MEHLER, J. (eds.): "Connections and symbol" - Elsevier, Amsterdam, 1988
- PINKER, Steve: "The language instinct: the new science of language and mind" - Penguin, London, 1994
- PINKER, Steve: "How the mind works" - Norton, New York, 1997
- PINZON, L. & MIDGLEY, G.: "Developing a systemic model for the evaluation of conflict"- SRBVS, 17(6) 2000
- PIPPENGER, Nicholas: "Complexity theory". Sc. American, 238 (6) 1978
- PITELKA, Louis et al.: "Plant Migration and Climate Change" - Amer. Sc., V.85 (5), 1997
- PITRAT, J.: "Connaissance et métaconnaissance", in Le Moigne, J.L. (ed): "Intelligence des mécanismes et mécanismes de l' intelligence". Fayard, Paris, 1980
- PITTARELLI, Michael: "Reconstructability analysis: an overview". Rev. Intern. de Systémique, 4 (1) 1990
- PITTENDRIGH, C.S.: "Adaptation, natural selection and behavior", in A.Roe & G.G. Simpson (eds): "Behavior and evolution". Yale Univ. Press, New Haven, Conn., 1958
- PITTS, W. & Mc CULLOCH, W.S.: "How we know universals: The perception of auditory and visual forms". Bul. Math. Biophysics, 9 (p.124-47), 1947
- PIZZORNO, Alexandre: "L'incomplétude des systèmes". Connexions nr.9-10, L'Epi, Paris, 1974
- PLAGNOL, Jean Louis: "Mécanisme hôte d'un système autonome." Rev.Internat. Systémique, 11(5) 1997
- PLATO, J. von: "Probability and determinism". Philos. of Science, 49 (1), 1982
- PLATT, John: "Theorems on boundaries in hierarchical systems", in Whyte, L.L. et al.: "Hierarchical structures". American Elsevier, New York, 1969
- PLOTKIN, H.C. (Ed): "The Role of Behavior in Evolution" - MIT Press, Cambridge, MA, 1988
- PLOTKIN, Henry: "The Nature of Knowledge". Allen Lane, 1994

- PLOTKIN, Henry: "People do more than imitate" - *Sc. Amer.*, October 2000
- PLUTCHIK, R.: "The psychology and biology of emotion" - Harper Collins, New York, 1944
- PÖPPEL, Ernst: "Oscillations as possible basis for time perception" - In: J.T.Frazer(ed.): "The study of time" - Springer, Berlin, 1972
- PÖPPEL, Ernst: "Mindworks: time and conscious experience" - Harcourt, Boston, 1988
- PÖPPEL, Ernst: "Das Drei-Sekunden Bewusstsein" - *Psychologie Heute*, 10, 1993
- POERKSEN, B. & von Foerster, H.: "The metaphysics of ethics" - *C&HK*, 9(3-4) 2002
- POINCARÉ, Henri: "Les formes d'équilibre d'une masse fluide en rotation" - *Rev. Gén. des Sciences*, Paris, 3, 1892
- POINCARÉ, Henri: "Sur la stabilité de l'équilibre des figures piriformes affectées par une masse fluide en rotation" - *Philos. Trans. A* 198, 1901
- POINCARÉ, Henri: "La valeur de la science" - Flammarion, Paris, 1902
- POINCARÉ, Henri: "La Science et l'Hypothèse" - Flammarion, Paris, 1912, reprinted 1938
- POLANYI, Michel: "The tacit dimension" - Doubleday, New York, 1966
- POLANYI, M.: "Life's irreducible Structure" - *Science*, Vol. 160, p.1308-12, 1968
- POLKINGHORNE, D.: "Methodology for the human sciences" - State Univ. New York Press, Albany, 1983
- PONTING, Clive: "A green history of the world: the environment and the collapse of great civilizations" - Penguin Books, New York, 1991
- POPPER, Karl: "The Logic of Scientific Discovery" - Basic Books, New York, 1959
- POPPER, Karl: "The self and its brain" - Springer, New York, 1974
- POPPER, Karl: "The open universe: An argument for indeterminism" - Rowan & Littlefield, Totowa, NJ, 1982
- POPPER, Karl: "Conjectures and refutation" - Routledge, London, 1989
- POPPER, Karl: "Alles Leben ist Problemlösen. Über Erkenntnis, Geschichte und Politik" - Piper, München, 1994
- POPPER, Karl: "Knowledge and the body-mind problem. In defence of interaction" - Routledge, London, 1994
- PORT, F.P. & VAN GELDER, T.(eds.): "Mind as motion: explorations in the dynamics of cognition" - MIT Press, Cambridge, MA., 1995
- PORTER, Alan L.: "Forecasting technological sustainability" - Proc. 42nd ISSS Conference, Atlanta, 1998
- PORTER, Arthur: "Cybernetics simplified". Unibooks, English Universities Press, London, 1969
- PORTER, Brian: "Requisite variety in the systems and control sciences". *Intern. J. Gen. Systems*, 2 (4) 1976
- POSNER, M.I. (ed.): "Foundations of cognitive science" - MIT Press, Cambridge MA., 1989
- POSNER, Roland et al.: "Semiotik: ein Handbuch zu den zeichentheoretischen Grundlagen von Natur und Kultur" (3 vols.) - de Gruyter, Berlin, 1997-99
- POSNER-LANDSCH, M.: "Synthetische Theorien der Kultur-Evolution" - Nodus Verlag, Münster, 1991
- POSTELNICU, PAUL & DRAGAN, J.C.: "Stephan ODOBLEJA, the man and his work". *Cyb. Acad. Odobleja Newsletter*, Milano, 1986, 10
- POSTELNICU, Paul: "From Entelechy to the feedback system hypothesis". *Cyb. Acad. Odobleja Newsletter*, Milano, 1984, 6
- POSTELNICU, Paul: "The part played by feedback in the development process". *Cyb. Acad. Odobleja Newsletter*, Supl., Milano, 1985-86
- POSTON, T. & STEWART, I.: "Catastrophe theory and its applications". Pitman, London, 1978
- POUGET, Pierre-Marie: "Notes sur le concept d'émergence". Institut de la Méthode, Symp. écrit, nr. 16, Bienne, 1992
- POWERS, W.T. et al.: "A general feedback theory of human behavior". *SGSR Yearbook*, 5, 1960
- POWERS, W.T.: "Behavior: The Control of Perception" - Aldine, Chicago, 1973
- POWERS, W.T.: "The Cybernetic revolution in psychology". *ASC Cyb. Forum*, VIII (3/4) 1976
- PRAEHOFER, Herbert: "Systems theory instrumented modeling and simulation methodology". *Cyb. & Systems*, 22 (3) 1991
- PRAT, Henri: "Le Champ unitaire en biologie". Presses Univ. de France, Paris, 1964
- PRAT, Henri: "L'espace multi-dimensionnel". Presses de l'Université, Montreal, 1971
- PREM, Erich: "Aspects of rules and connectionism". *Cybernetics & Systems Research* 92, World Scientific, Singapore, 1992
- PREM, Erich: "The implications of embodiment for cognitive theories: a systems view" - *Proceed. 14th Meet. on Cybernetics and Systems*, Vienna, 1998
- PRESSMAN, Todd Evan: "A synthesis of systems inquiry and the Eastern mode of inquiry". *Syst. Research*, 9 (3) 1992
- PREWO, R., RITSERT, J. & STRACKE, E.: "Systemtheoretische Ansätze in der Soziologie: Eine kritische Analyse". Rowohlt Tasch. Verlag, Hamburg, 1973
- PRIBRAM, K.H.(Ed.): "On the Biology of Learning" - Harcourt, Brace & World, New York, 1969
- PRIBRAM, K.H.: "Languages of the Brain" - Brooks/Cole, Monterey, California, 1971
- PRIBRAM, K.H.: "Brain and perception: Holonomy and structure in figural processing" - L. Erlbaum, Hillsdale, NJ, 1991
- PRIGOGINE, I. & WIAME, J.M.: "Biologie et thermodynamique des phénomènes irréversibles", *Experimentia*, 2 (p.451-3) 1940
- PRIGOGINE, Ilya: "Etude thermodynamique des phénomènes irréversibles". Dunod, Paris or Desoer, Liège, 1947
- PRIGOGINE, Ilya: "Thermodynamics of irreversible processes". Thomas Press, Springfield, Ill., 1955
- PRIGOGINE, Ilya: "Non equilibrium statistical mechanics". Interscience, New York, 1962
- PRIGOGINE, Ilya: "Temps, structure et entropie". *Bul. Acad. Royale Belge*, 1967
- PRIGOGINE, Ilya: "Symmetry-breaking instabilities in biological systems". *Nature*, 223, p.213-16, 1969
- PRIGOGINE, I. & NICOLIS, G.: "Biological order, structures and instabilities". *Quart. Rev. of Biophysics*, 4, 1971
- PRIGOGINE, I. & BABLOYANTZ, A.: "La thermodynamique de la vie". *La Recherche*, nr. 24, 1972
- PRIGOGINE, Ilya: "Irreversibility as a symmetry-breaking process". *Nature*, 248, 1973a
- PRIGOGINE, Ilya: "Time, irreversibility and structure". in Mehra, J. (ed.): "The physicist's conception of nature". Reidel, Dordrecht, 1973b
- PRIGOGINE, Ilya: "Order through fluctuation: self-organization and social system", in Jantsch, E. & Waddington, C. (eds): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1976
- PRIGOGINE, I. et al.: "The evolution of complexity and the laws of nature". 3rd Club of Rome report, 1978
- PRIGOGINE, Ilya: "Time, structure and fluctuations". Nobel Lecture in Chemistry 1977. in *Nouvelles Cult. de Belgique*, 1978, or *Science*, 201, (p.775-85), 1978
- PRIGOGINE, I. et STENGERS, I.: "La nouvelle alliance". Gallimard, Paris, 1979. (in English: "Order out of chaos". Bantam Books, New York, 1984)
- PRIGOGINE, Ilya: "From being to becoming: time and complexity in the physical sciences". W.H. Freeman, San Francisco, 1980
- PRIGOGINE, Ilya: "Time, irreversibility and randomness", in Jantsch, E. (ed.): "The evolutionary vision". (an AAAS Symposium), Westview Press, Boulder, Colorado, 1980a
- PRIGOGINE, Ilya: "Physique, temps et devenir". Masson, Paris, 1982
- PRIGOGINE, I. & ALLEN, P.M.: "The challenge of complexity", in Schieve, W. & Allen P.M. (eds): "Self-organization and dissipative structures". Univ. of Texas Press, Austin, 1982
- PRIGOGINE, Ilya: "Nonequilibrium thermodynamics and chemical evolution: an overview", in Nicolis, G. (ed): "Aspects of chemical evolution". Wiley, New York, 1984a
- PRIGOGINE, Ilya: "The rediscovery of time". *Zygon*, 19 (4) 1984b
- PRIGOGINE, Ilya: "Coping with the irrational". Faculty of Physics, Univ. of Barcelona, 1985
- PRIGOGINE, I. & NICOLIS, G.: "Self-organization in non-equilibrium systems", in Hazewinkel, M. et al. (eds.): "Bifurcational analysis". Reidel, Dordrecht, 1985
- PRIGOGINE, Ilya: "The Open Universe". *Cent. Stud. Stat. Mech.*, Univ. of Texas Press, Austin, 1986
- PRIGOGINE, I. & ELSKENS, Y.: "Irreversibility, stochasticity and non-locality in classical dynamics". *Serv. de Chimie-Physique, Univ. Libre de Bruxelles*, 1987
- PRIGOGINE, Ilya: "The Philosophy of Instability" - *Futures*, 21 (4) , 1989
- PRIGOGINE, Ilya: "What is entropy?". *Naturwiss.*, 76 (1) 1989
- PRIGOGINE, Ilya: "The microscopic meaning of irreversibility" *Zeit. Phys. Chemie*, 27 (3) 1989a
- PRIGOGINE, I. et al.: "Integrability and chaos in classical and quantum mechanics". *Chaos, Solitons and fractals*, 1 (1) 1991
- PRIGOGINE, I. et STENGERS, I.: "Entre le temps et l'éternité". Flammarion, Paris, 1992
- PRIGOGINE, Ilya: "La Fin des Certitudes". Odile Jacob, Paris, 1996
- PRIMAS, H.: "Synchronizität und Zufall". - *Zeit. für Parap.und Grenzgeb. der Psych.*, 38 (1/2), 1996
- PRINGLE, John, W.S.: "On the parallel between learning and evolution". *SGSR Yearbook*, 1, 1956
- PROBST, G.J.B. & SIEGWART, H.: "Integriertes Management" - Haupt, Bern, 1985

- PROBST, G.J.B.: "Selbst-Organisation: Ordnungsprozesse in soziale Systemen aus ganzheitlicher Sicht" - P. Paray, Berlin, 1987
- PROCTOR, Lorna: "Biocybernetics of the central nervous systems". Little Brown, Boston, 1969
- PROKOP, A.: "Systems analysis and synthesis in biology and biotechnology". IJGS., 8, 1982, p. 7-31
- PROKOPISHINA, Natalia: "Comparing cultural systems: russian and american national mentalities" - Proc. 16th Meet. cyb. & syst., Vienna, 2002
- PROKOPSKA, Aleksandra: "Methodology of the morphological analysis" - Polytechnical Univ. Wroclaw, Poland, 1998
- PROOPS, J.L.: "Organization and dissipation in economic systems". J. Social and Biol. Structures, 6, 1983
- PROOPS, J.L.: "Thermodynamics and economics", in van Gool, W. & Bruggom, J.J. (eds): "Energy and time in the economic and physical sciences". North Holland, Amsterdam, 1985
- PROOPS, J.L.: "Entropy, information and confusion in the social sciences". J. Interdisc. Economics, 1, 1987
- PRUSINKIEWICZ, P. & LINDENMAYER, A.: "The algorithmic beauty of plants" - Springer, New York, 1990
- PRYZSTUPA, Frank W.: "Diagnosis and action in sociotechnological systems" - Systems, 2(1), Polytechnical Univ. Wroclaw, Poland, 1997
- PUNTE, Carlos: "Treasures inside the bell: hidden order in chance" (about fractals in the Gaussian curve) - World Scientific, London, 2002
- PUGH, G.E.: "The biological origin of human values" - Basic Books, New York, 1977
- PUTNAM, H.: "Representation and Reality" - The MIT Press, Cambridge, Mass., 1988.
- PYLYSHYN, Z.W.: "Computation and cognition toward a foundation for cognitive science" - MIT Press, Cambridge, Mass., 1984
- QIAN, Xuesen et al.: "A new discipline of science: the study of open complex giant systems" - in Midgley, G. & Wilby J. (eds.): Proceedings of the 1995's Beijing Conference on Systems, Univ. of Hull, 1995
- QUAMMEN, David: "Archipelago Earth" - Time. Special Issue, Nov. 1997
- QUASTLER, H. (ed): "Information theory in biology". Univ. of Illinois Press, Urbana, 1953
- QUASTLER, H. (ed): "Homeostatic mechanisms". Brookhaven Lab. Upton, 1958
- QUASTLER, H.: "The emergence of biological information" - Yale Univ. Press, New Haven, 1964
- QUELLER, D.C.: "Kinship, Reciprocity and Synergism in the Evolution of Social Behavior" - Nature V.318, p.366-67, 1985
- QUILICI-PACAUD, Jean-François: "Evolution, systématique et contingence". Inst. de la Méthode, Symp. écrit, nr.13, Bienne, 1993
- QVORTRUP, Lars: "Orders of artificiality (Kant, Simon, Maturana, Bateson, Luhmann)" - C&HK, 2(2), 1993
- QVORTRUP, Lars: "The controversy over the concept of Information" - C&HK, 1(4), Aalborg, 1993
- QVORTRUP, Lars: "How is society possible? The epistemology of social constructivism (a comment on J.R. Searle's "Construction of social reality")" - C&HK, 3(4) 1996
- RAADT, Donald de: "Contributions of global systems of ethics to sustainable civilization" - Proc. 42nd. ISSS Meeting, Atlanta, 1998
- RAADT, J.D. de: "Disinformation and time lags in information" Cyb. & Systems, 20 (4) 1988
- RAADT, J.D. de: "Multi-modal systems design". Syst. Research, 6 (1) 1988
- RAADT, J.D. de: "Interdependence and information sharing in social systems". Cyb & Systems, 21 (6), 1990
- RAADT, J.D. de: "Information and managerial wisdom". Paradigm Public., Pocatello, Idaho, 1991
- RAADT, J.D. de: "Expanding the horizon of information systems design". Syst. Research, 12 (3) 1995
- RAADT, J.D. de: "Design of an Undergraduate Programme in Informatics and Systems Science" - 14th WACRA Conference, Universidad Complutense, Madrid, 1997
- RAADT, Veronica de: "Multi-modal system method: the impact of normative factors on community viability" - SRBVS, 18(2)
- RABB, T. & ROTBERG, R. (eds.): "Climate and History: Studies in Interdisciplinary History" - Princeton Univ. Press, 1981
- RACCAH, Pierre-Yves: "Argumentation and language system". Proc. 2nd. Eur. Congr. Syst. Sc., V.IV, Praha, 1993
- RADERMACHER, F.J.: "Cognition in systems". Cyb. & Systems, 27 (1) 1996
- RAELIN, J.A.: "Work- based learning" - Prentice Hall, Upper Saddle River, N.J., 2000
- RAFFAI, Maria: "How to get closer to the new Economy: new aspects and paradigm in Business Modeling" - Proc. 9th IDIMT, Zádov, Univ. Press R. Trauner, Linz
- RAGADE, R.K.: "Dynamic systems design methodology: a general living systems viewpoint" - Proc. 26th Ann. Meet. SGSR, 1982, p. 181-191
- RAMADE, François: "L'ecologie a-t-elle un avenir?". La Recherche, 24 (253) Avril 1993
- RAMAEKERS, Jean: "We love Big Brother". Cybernetica, 38 (4) 1995
- RAMER, A. & LANDER, L.: "Systems problems and computer techniques: numerical versus expert systems approaches". Cyb. & Systems, 21 (4) 1990
- RAMLOT, Michel: "L'acquisition de l'autonomie comme finalité de l'éducation". Analyse de Systèmes, XV (1) 1989
- RANDERS, J. (ed): "Elements of the systems dynamics method". M.I.T., Cambridge, Mass., 1980
- RANDRUP, Axel: "An alternative to materialism: converging evidence from nature, spirituality and natural science" - C&HK, 4(4) 1997
- RANDRUP, Axel (rev.): "Evolution and cognition: the journal of the Konrad Lorenz Institute, Austria" - C&HK, 4(1), 1997
- RAPOPORT, Anatol: "What is information". ETC. V.10, 1953
- RAPOPORT, Anatol: "The promise and pitfalls of information theory". Behav. Science nr.1, 1956
- RAPOPORT, Anatol: "Critiques of game theory". Behav. Science, V.4 (1), 1959
- RAPOPORT, A. & HORVATH, W.J.: "Thoughts on organization theory". SGSR Yearbook, 4, 1959
- RAPOPORT, Anatol: "Mathematical aspects of general systems analysis". SGSR Yearbook, 11, 1966
- RAPOPORT, Anatol: "Fights, games and debates". Univ. of Michigan Press, Ann Arbor, 1967
- RAPOPORT, Anatol: "A philosophical view", in Milsum, J. (ed) "Positive feedback". Pergamon Press, New York, 1968
- RAPOPORT, Anatol: "Methodology in the physical, biological, and social sciences". SGSR Yearbook, 14, 1969
- RAPOPORT, Anatol: "Philosophical perspectives on Living Systems" - Behav. Sci., 25, 1980, p. 56-64
- RAPOPORT, Anatol: "The use of mathematical isomorphisms in GST", in Klir, G.(ed): "Trends in General Systems Theory". Wiley Interscience, New York, 1972a
- RAPOPORT, Anatol: "The search for simplicity", in Laszlo, E. (ed): "The relevance of General Systems Theory". Braziller, New York, 1972b
- RAPOPORT, A.: "Semantics" - Th. J. Cromwell Co., New York, 1975
- RAPOPORT, Anatol: "Decision theory and decision behavior" - Kluwer, Dordrecht, Boston, 1989
- RAPOPORT, Anatol: "General Systems Theory". Abacus, Tunbridge Wells, 1986
- RAPOPORT, Anatol: "The problem of peace from a general systems theory perspective" - Prod. 42nd. ISSS Conference, Atlanta, 1998
- RASHEVSKY, Nicholas: "Mathematical biophysics". Chicago Univ. Press, 1938
- RASHEVSKY, Nicholas: "Topology and life: in search of general mathematical principles in biology and sociology". SGSR Yearbook, 1, 1956
- RASHEVSKY, Nicholas: "Mathematical biophysics, physico-mathematical foundations of biology". 2 vols. Dover, New York, 1960
- RASHEVSKY, Nicholas: "Organismic sets: outline of a general theory of biological and social organisms". SGSR Yearbook, 12, 1967
- RASHEVSKY, N.: "Organismic sets: Outline of a general theory of biological and social organisms" - Bull. Math. Biophys., 29, 1967
- RASMUSSEN, S, MOSEKILDE, E & STERNMAN, J.D.: "Bifurcations and chaotic behavior in a model of the economic long wave". Syst. Dynamics Rev., 1 (p. 92-110), 1985
- RAY, George: "Innovation in the long Cycle". Lloyds Bank Rev., nr.135, Jan. 1980
- REASON, Peter (ed.): "Participation in human inquiry" - Sage, London, 1994
- REASON, P. & BRADBURY, H. (eds.): "Handbook of action research, participative inquiry and practice" - Sage, London, 2001
- REASON, Peter: "The practice of co-operative inquiry" (a special issue) - SPAR, 15(3), 2002
- REAVILL, Lawrence R.P.: "A systems based stakeholder model of higher education" - Proc. 42nd ISSS Conf., Atlanta, 1998
- REBBI, Claude: "Solitons". Sc. American, 240 (2) 1979
- REBER, A.S.: "Implicit learning and tacit knowledge" - Oxford Univ. Press, New York, 1993
- RECHENBERG, P. & POMERBERG, G.(eds.): "INFORMATIK Handbuch" - Hanser Verlag, München, 1997
- REDMAN, Charles L.: "Human impact on ancient environments" - Univ. of Arizona Press, Tucson, AZ, 1999
- REESE-SCHÄFER, Walter: "Niklas Luhmann, zur Einführung" - Junius Verlag, Hamburg, 1999

- REEVE, C. & HUXLEY, J.: "Some problems in the study of allometric growth", in Huxley, Julian (ed): "Problems of relative growth". Dover Publ., New York, 1972
- REEVES, Wayne W.: "Meta-cognition and complexity". Proc. ISSS Meeting, Denver, 1992
- REICE, Seth R.: "Non equilibrium determinants of biological community structure". Amer. Scientist, 82 (5) 1994
- REICHENBACH, Hans: "Philosophie der Raum-Zeit Lehre". Springer, Berlin, 1928
- REICHENBACH, Hans: "The direction of time". Univ. of California Press, Berkeley, 1956
- REIDL, Rupert: "Order in living Organisms: A Systems Analysis of Evolution" - Wiley, New York, 1978
- REINER, J.M.: "The organism as an adaptive control system". Prentice Hall, Englewood Cliffs, 1968
- REISER, Oliver L.: "Non-aristotelician logic and the crisis in science". Scientia, III, 1937
- REISER, Oliver L.: "Logic, Cybernetics and general semantics". Gen. Semantics Bull. (16/17) 1955
- RENDERS, J.M.: "Algorithmes génétiques et réseaux de neurones" - Hermès, Paris, 1997
- RESCHER, Nicholas: "Introduction to value theory". Prentice Hall, Englewood Cliffs, 1969
- RESCHER, Nicholas: "Many-valued logic". Mc Graw Hill, New York, 1969
- RESCHER, Nicholas: "Conceptual idealism" - Basil Blackwell, Oxford, 1973
- RESCHER, Nicholas: "Methodological pragmatism" - Basil Blackwell, Oxford, 1977
- RESCHER, Nicholas: "Scientific progress: A philosophical essay on the economics of research in natural science". Univ. of Pittsburgh, Penn., 1978
- RESCHER, Nicholas: "Cognitive systematization: A systems theoretic approach to a coherentist theory of knowledge". B. Blackwell, Oxford, 1979
- RESCHER, Nicholas: "Induction". Basil Blackwell, Oxford, 1980
- RESCHER, N. & BRANDON, R.: "The logic of inconsistency". Basil Blackwell, London, 1980
- RESCHER, Nicholas: "Empirical enquiry". Athlone Press, London, 1982
- RESCHER, Nicholas: "The strife of systems: an essay on the grounds and implications of philosophical diversity" - University of Pittsburg Press, 1985
- RESNICK, M.: "Turtles, termites and traffic jams: explorations in massively parallel microworlds" - Bradfordbook, MIT Press, Cambridge, MA, 1994
- REVENTLOV, Iven: "Studier af komplicerede psykobiologiske faenomener" - (Doctoral thesis in Danish, Munkgaard, Copenhagen, 1970)
- REYES, A. & ZARAMA, R.: "The process of embodying distinctions; a re-construction of the process of learning" - C&HK, 5(3) 1998
- RHEINBERGEN, Hans: "Limits of the genetic lexicon". Am. Sci. 89(1), jan.2001
- RIBETTE, Regis: "Autonomie des acteurs individuels dans les organisations collectives" - Rev. Internat. Systémique, 11(5) 1997
- RICHARDS, Laurence: "Constraint theory: A framework for social modelling". Proc. 22nd SGSR Meeting, Washington, 1978
- RICHARDSON, George P.: "Feedback thought in social science and systems theory" - Univ. of Pennsylvania Press, Philadelphia, 1992
- RICHARDSON, Lewis F.: "The Problem of contiguity". SGSR Yearbook, 6, 1961
- RICHMOND, B.: "The thinking in systems thinking: some essential skill" - Pegasus, Waltham, 2000
- RICHTER, H.E.: "Wachstum bis zur Katastrophe?" - Deutsche Verlagsanstalt, Stuttgart, 1974
- RICOEUR, Paul et al.: "The rule of metaphor multidisciplinary studies in the creation of meaning in language" - Toronto Univ. Press, 1978
- RIDLEY, Matt: "The Origins of Virtue; human instincts and the evolution of cooperation" - Penguin Books, Putnam, New York, 1996
- RIDLEY, Mark: "Yuck by the yard", a review of C. ZIMMER's book "Parasite Rex" - N.Sc., Nr. 2252, August 19th. 2000.
- RIEDL, R.: "Biologie der Erkenntnis" (2te. Auflage) - Paul Parey, Hamburg, Berlin, 1980
- RIEDL, R.: "Die Spaltung des Weltbildes: Biologische Grundlagen des Erklärens und Verstehen" - P. Parey, Berlin, 1985
- RIEDL, R. & WUKETITS, M. (Hrsg.): "Die Evolutionäre Erkenntnistheorie Bedingungen, Lösungen, Kontroversen" - P. Paray, Berlin, 1987
- RIEGAS, V. & VETTER, Ch. (eds.): "Zur Biologie der Kognition" - Suhrkamp, Frankfurt/M., 1990
- RIEGLER, Alexander: "Constructivist artificial life" - Ph.D. Thesis, Univ. of Technology, Vienna, 1994
- RIEGLER, Alexander: "The end of science: can we overcome cognitive limitations?" - Evolution & Cognition, 4(1), 1998
- RIEGLER, Alexander. et al.(eds.): "Understanding representation in cognitive science" - Kluwer Ac./Plenum, New York, 1999
- RIEGLER, Alexander: "Asymmetry of behavior and evolution" - Proc. 15th Cybernetics & Systems Meet. - Austr. Soc. Cyb. Stud., Vienna, 2000
- RIFKIN, Jeremy: "Entropy: into the greenhouse world" - Bantam Books, N.Y., 1989
- RIND, D.: "Complexity and Climate" - Science. Vol. 284, p. 105-7, April 2, 1999
- RINGLE, Martin: "The cybernetic thesis and mechanism". ASC. Cyb. Forum, VIII (1/2) 1976
- RIOLO, R.L.: "Lookahead planning and latent learning in a classifier system", in MEYER, J.A. & WILSON, S.: "Simulation of Animal Behavior: From Animals to Animats" - M.I.T. Press, Cambridge, MA, 1990
- RIOT, Philippe: "Fondements mathématiques sous-jacents des relateurs arithmétiques". Proc. Eur. Congr. on Systems Science, Lausanne, 1989
- RITZ, Dave: "The benefits of a good school". New Scientist, nr.1761, 1991 (on fish schools!)
- ROBB, Fenton: "The management of complexity". Transact. Inst. of Measur. and Control, V.10 (3), 1988
- ROBB, Fenton: "Cybernetics and suprahuman autopoietic systems". Syst. Practice, 2 (1) 1989
- ROBB, Fenton: "Morphostasis and morphogenesis". Syst. Research, 7 (3) 1990
- ROBB, Fenton: "On the application of the theory of emergence and of the law of maximum entropy production to social processes". Syst. Practice, 3 (4) 1990
- ROBB, Fenton: "Autopoiesis and supra-human systems" - IJGS, 21, 1992
- ROBBINS, S. & OLIVA, T.A.: "An empirical classification of General Systems Theory concepts" - Proc. 26th Ann. Meet. SGSR, 1982, p. 3-14
- ROBERT, R. et SOMERIA, J.: "La persistance des tourbillons à deux dimensions". La Recherche, nr.245, 1992
- ROBERT-DEMONTROND, Ph. & THIEL, D.: "Du Cognitisme au Connexionisme: Perspectives de Recherches en Management". Rev. Intern. de Systémique, 10 (5), 1996
- ROBERTIS, E.M. de et al.: "Homeobox Genes and the Vertebrate Body Plan" - Sc. Amer., Vol.269, 2, p.46-52
- ROBERTSON, Robin: "Some-thing for no-thing: G.Spencer Brown's laws of form" - C&HK.6 (4), 1999
- ROBERTSON, Robin: "One, two, three...continuity: C.S. Peirce and the nature of continuum" - C&HK, 8 (1-2), 2001
- ROBINSON, B. & WILSON, F.: "Soft systems methodology and dialectics in an information environment: case study of the battle of Britain" - SRBVS, 20(3) 2003
- ROCHA, Luis M.: "Eigenbehavior and Symbols" - Systems Research, V.13 (3), 1996
- RODRIGUEZ DELGADO, Rafael: "A possible model for ideas" (pers. comm., paper published at Yale Univ., 1956)
- RODRIGUEZ DELGADO, Rafael: "Systems Dynamics in a General Systems Theory framework". Internat. Conf on Human Syst. Dynamics Sevilla, 1986
- RODRIGUEZ DELGADO, Rafael: "Teoría de sistemas: conceptos básicos". Rev. Intern. de Sistemas, 1 (2), Madrid, 1989
- RODRIGUEZ DELGADO, Rafael: "The application of systems thinking to the design of educational systems". Workshop Monterrey, 1990
- RODRIGUEZ DELGADO, Rafael: "Pensamiento global, analítico y sintético". Rev. Intern. de Sistemas, 3 (3), Madrid, 1991
- RODRIGUEZ DELGADO, Rafael: "Systems thinking in Europe". Plenum Press, Huddersfield, UK, 1991
- RODRIGUEZ DELGADO, Rafael: "Transformation theory", in JACKSON, M (Ed.): "Systems Thinking in Europe" - Plenum Press, New York, 1991
- RODRIGUEZ DELGADO, Rafael: "Systems education and knowledge transfer, reproduction and mutation". 2nd. Eur. Congr. of Systems Science, Praha, 1992
- RODRIGUEZ DELGADO, R. & BANATHY, B. (eds): "International Systems Science Handbook". Systemic Public., Madrid, 1993
- RODRIGUEZ DELGADO, Rafael: "Systems dialectics for integrated development", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Publications, Madrid, 1993
- RODRIGUEZ DELGADO, Rafael: "Systems theory: basic concepts", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- RODRIGUEZ DELGADO, Rafael: "Systems theory; foundations" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- RODRIGUEZ DELGADO, Rafael: "Teoría de sistemas y gestión de las organizaciones" - Inst. Andino de Sistemas, Lima, Perú, 1994
- RODRIGUEZ DELGADO, Rafael: "Del Universo al Ser Humano: Hacia una Concepción Planetaria para el Siglo XXI" - Mc Graw Hill, Madrid, 1997

- RODRIGUEZ ULLOA, Ricardo: "The Problem-Solving System: Another Problem-Content System" - *Systems Practice*, Vol.3, Nr.1, 1988
- RODRIGUEZ ULLOA, Ricardo: "Cultural Systems, Strategic Management and Organizational Change" - *Intern. Systems Science Handbook*, Sociedad Española de Sistemas Generales (SESSE), Madrid, 1992 (Avail. from Univ. de Valencia, Spain)
- RODRIGUEZ ULLOA, Ricardo: "Cultural systems, strategic management and organizational change", in Banathy, B. & Rodriguez Delgado, R.: "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- RODRIGUEZ ULLOA, Ricardo: "La Sistémica, los sistemas blandos y los sistemas de información" - Univ. del Pacífico, Lima, Perú, 1994
- RODRIGUEZ ULLOA, Ricardo: "A note on the correspondence between complexity and systems theory" - *SPAR*, 12(3), 1999
- RODRIGUEZ ULLOA, Ricardo: "Glossary" to the former work - The 43rd Meeting of the I.S.S.S. - Asilomar, 1999
- RODRIGUEZ ULLOA, Ricardo: "Soft System Dynamics Methodology (SSDM): A tool for social systems analysis and design" - The 43rd Meeting of the I.S.S.S. - Asilomar, 1999
- ROESSLE, Alfred: "The role of social hierarchies in living systems" - *Proc. 42nd ISSS Conference*, Atlanta, 1998
- ROJAS, R.: "Neural networks; a systemic introduction" - Springer, New York, 1996
- ROKEACH, M.: "Understanding human values: individual and societal" - Free Press, New York, 1979
- ROLLS, Edmund: "The brain and emotion" - Oxford Univ. Press, Oxford, 1999
- ROMM, Norma R.A.: "Interdisciplinary practice as reflexivity" - *SPAR*, 11 (1), 1998
- ROMM, Norma: "Accountability in social research: issues and debates" - Kluwer/Academic/ Plenum, New York, 2001
- ROMM, Norma: "A trusting constructivist approach to systemic inquiry: exploring accountability" - *SRBVS*, 19(5) 2002
- ROSEN-RUNGE, P.H.: "Toward a theory of parts and wholes: an algebraic approach". *SGSR Yearbook*, 11, 1966
- ROPOHL, G.: "Eine Systemtheorie der Technik: zur Grundlegung der Allgemeinen Technologie" - Carl Hauser, Munich, 1979
- RORTY, Richard: "Philosophy and the mirror of nature". Blackwell, Oxford, 1980
- RORTY, R.: "Consequences of Pragmatism" - University of Minnesota Press, Minneapolis, 1982
- ROSCH, E. & LLOYD, B.B. (eds.): "Cognition and categorization" - Erlbaum, Hillsdale, N.J., 1978
- ROSE, J. (ed): "Advances in cybernetics and systems". 3 vols, Gordon & Breach, New York, 1975
- ROSE, J. & BILCIU, C.(eds): "Modern trends in cybernetics and systems". Springer, Berlin, 1977
- ROSE, J. (ed): "Current topics in systems and cybernetics". Springer, Heidelberg, 1978
- ROSE, J.(ed): "Cybernetics and systems: Present and future". Thalès, Paris, 1987
- ROSE, J.: "Quelques remarques sur la TGS et ses applications". *Rev. Intern.de Systémique*, 4 (1) 1990
- ROSE, J.: "Cybernetics, technological barriers and education". *Kybernetes*, 20 (7) 1991
- ROSE, Jeremy: "Soft system methodology as a social science research tool" - *SRBVS*, 14(4) 1997
- ROSE, Steven: "The making of memory". Anchor Books Doubleday, New York, 1992
- ROSEN, David W.: "The development of a sustainable system under uncertainty" - *Proc. 42nd ISSS Conference*, Atlanta, 1998
- ROSEN, Robert: "A logical paradox implicit in the notion of a self-reproducing automaton". *Bul. Math. Biophys.*, 21, 1959
- ROSEN, Robert: "A relational theory of biological systems". *SGSR Yearbook*, 5, 1960
- ROSEN, Robert: "The representation of biological systems". *SGSR Yearbook*, 5, 1960
- ROSEN, Robert: "Dynamical systems theory in biology". 2 vol. Wiley Interscience, New York, 1970
- ROSEN, Robert: "Some systems theoretical problems in biology", in Laszlo, E. (ed): "The relevance of General Systems Theory". Braziller, New York, 1972
- ROSEN, Robert: "Biological systems as organizational paradigms". *Intern. J. Gen. Systems*, 1 (3) 1974
- ROSEN, Robert: "On the design of stable institutions". *Intern. J. Gen. Systems*, 1 (1) 1974
- ROSEN, Robert: "Some temporal aspects of political change". *Intern. J. Gen. Systems*, 1 (2) 1974
- ROSEN, Robert: "Complexity as a system property". *Intern. J. Gen. Systems*, 3 (4) 1977
- ROSEN, Robert: "Self organization in non-equilibrium systems" by G.Nicolis & I.Prigogine: a review. *Intern. J. Gen. Systems*, 4 (4) 1978
- ROSEN, Robert: "Anticipatory systems in retrospect and prospect". *SGSR Yearbook*, 24, 1979
- ROSEN, Robert: "Fundamentals of measurement and representation of natural systems". North Holland, Amsterdam, 1979
- ROSEN, Robert: "Old trends and new trends in General Systems research". *Intern. J. Gen.Systems*, 5 (3) 1979
- ROSEN, Robert: "Anticipatory systems". Pergamon, Oxford, 1985
- ROSEN, Robert: "Theoretical biology and complexity". Academic Press, Orlando, FL., 1985
- ROSEN, Robert: "Some comments on systems and system theory". - *IJGS*, 13, 1986
- ROSEN, Robert: "Life itself: A comprehensive inquiry into the Nature, Origin and Fabrication of Life" - Columbia University Press, New York, 1991
- ROSEN, Robert: "Anticipatory systems in retrospect and prospect", in Klir, G.(ed): "Facets of systems science". Plenum Press, New York, 1991a
- ROSEN, Robert: "Complexity and systems descriptions", in Klir, G. (ed): "Facets of systems science". Plenum Press, New York, 1991b
- ROSEN, Robert: "Comments on system theory", in Klir, G. (ed): "Facets of systems science". Plenum Press, New York, 1991c
- ROSEN, Robert: "The challenges of system theory", in Klir, G. (ed): "Facets of systems science". Plenum Press, New York, 1991d
- ROSEN, Robert: "The physics of complexity", in Klir, G. (ed): "Facets of systems science". Plenum Press, New York, 1991e
- ROSEN, Robert: "Some random thoughts about chaos and some chaotic thoughts about randomness". *J. Biol. Syst.*, 1 (1) 1993
- ROSEN, Robert: "Essays on life itself" - Colombia Univ. Press, New York, 1999
- ROSENBLATT, Frank: "The perceptron: A probabilistic model for information storage and organization in the brain" - *Psychological Review*, 65, p.368-408, 1958
- ROSENBLATT, F.: "Perceptrons and the theory of brain mechanisms". Cornell Aeronautic Lab. Report, 1961
- ROSENBLATT, F.: "Principles of neurodynamics: Perceptron and the theory of brain mechanisms". Spartan, Washington, 1962
- ROSENBLUETH, A. et al.: "Behavior, purpose and teleology". *J. Phil. of Science*, 10, 1943
- ROSENBLUETH, A. & WIENER, N.: "The role of models in science" *J. Phil. of Science*, 12, 1945
- ROSENBLUETH, A. & WIENER, N.: "Purposeful and non-purposeful behavior". *J. Phil. of Science*, 17 (p.318-26), 1950
- ROSENHEAD, J.: "Technology and change: the new Heraclitus" - Delacorte Press, New York, 1967
- ROSENHEAD, J.(ed.): "Rational analysis for a problematic world" - Wiley, Chichester, 1989
- ROSICKY, Antonin: "The danger of an anonymous power: (human) interface between computers and business organization" - *Proc. 6th IDIMT*, Zadov, Universitätverlag R. Trauner, Linz, 1998
- ROSICKY, Antonin: "From control to organizing: human dealing with information and computers in organization" - *Proc. 7th IDIMT*, Zadov, Universitätverlag R. Trauner, Linz, 1999
- ROSICKY, Antonin: "Information and human co-evolution-understanding information within social systems" - *Proc. 44th ISSS Meeting*, Toronto, 2000
- ROSICKY, Antonin: "System thinking, thinking abstract: agent of information and knowledge within systems and systems thinking" - *Proc. 8th IDIMT*, Zadov, Universitätverlag R. Trauner, Linz, 2000
- ROSICKY, Antonin: "Information generating system; information generating social systems" - *Proc. 16th Meet. on cybernetics and Systems*, Vienna, 2002
- ROSNAY, Joël de: "Le Macroscopie". Le Seuil, Paris, 1975 (Translated to English)
- ROSNAY, Joel de: "Le cerveau planétaire" - O. Orban, Paris, 1986
- ROSNAY, Joel de: "L' aventure du vivant" - Le Seuil, Paris, 1988
- ROSNAY, Joel de: "L'Homme Symbiotique: Regards sur le 3ème Millénaire" - Odile Jacob, Paris, 1995
- ROSS, J. & OLIVER, D.: "From fitness landscapes to knowledge landscapes" - *SPAR*, 12 (3), 1999
- ROSSEEL, Eric & van der LINDEN, Gert.: "Self-monitoring and self-steering in social interaction". *Kybernetes*, 19 (1) 1990
- ROSSEEL, Eric: "The discursive self and the emergence of supportive social bonds" - *Systemica*, 8(1). Thesis, Amsterdam, 1991
- ROSSI, A.: "Descartes y el estructuralismo contemporáneo" - *Phaenomenon*, FCEN, UBA, nro.2, Buenos Aires, Jul. 1977
- ROSSI, E.L.: "The psychobiology of mind-body healing" - W.W. Norton, New York, 1993
- ROSTOW, W.W.: "The stages of economic growth" - Cambridge University Press, 1960
- ROTH, G. & SCHWEGLER, H.: "Self-organizing systems: An interdisciplinary approach". Campus Verlag, Frankfurt, 1981

- ROTH, Wolff-Michael: "The evolution of Umwelt and communication" - C&HK, 6(4), 1999
- ROUKES, Michael: "Nanoelectromechanical systems face the future" - Phys. World, 14(2), feb., 2001)
- ROUVILLOIS, Gildas: "Space-time: a conceptual frame, or a mirror of brain symmetries?" - CASYS J., 2, Inst. de Math., Univ. de Liège, 1998
- ROUX, W.: "Die Selbstregulation". Berlin., 1914
- ROWE, W.D.: "Why systems science and cybernetics". SSC1, nr.1, IEEE Transact., 1965
- ROWLAND, G.: "Archetypes of systems design" - Systems Practice, Vol.8, Nr.3, June 1995.
- ROWLAND, Vernon: "Cybernetics and dynamic patterning". ASC Cyb. Forum, VIII (3/4) 1976
- RUBEN, B. & KIM, John (eds): "General Systems Theory and human communication". Hayden Book Co, New Jersey, 1976
- RUBIN, M.D.: "History of technological feedback", in Milsom, John (ed): "Positive feedback". Pergamon, New York, 1968
- RUBIN, Milton D. (ed): "Man in systems". Braziller, New York, 1971
- RUDOLF, G.: "Convergence properties of evolutionary algorithms" - Kovac, Hamburg 1997
- RUELLE, D. & TAKENS, F.: "On the nature of turbulence". Comm. Math. Physics, 20, 1971
- RUELLE, David: "Les attracteurs étranges". La Recherche, nr. 108, 1980
- RUELLE, D.: "Small random perturbations of dynamical systems and the definition of attractors". Com. Math. Phys. 82, 1981
- RUELLE, David: "Chaotic Evolution and Strange Attractors" - Cambridge Univ. Press, 1989
- RUELLE, David: "Le hasard et le chaos" - Odile Jacob, Paris, 1992 - (in English: "Chance and Chaos" - Princeton Univ. Press, 1994)
- RUESCH, J. & BATESON, G.: "Communication: the social matrix of psychiatry".- Norton, New York, 1987 (reprint)
- ROUGH, W.J.: "Nonlinear systems theory: The Volterra-Wiener approach". J. Hopkins Univ. Press, Baltimore, 1981
- RUMELHART, D.F. & ZIPSER, D.: "Feature discovery by competitive learning" - Cogn. Sci., 9, 1985
- RUMELHART, D. & MC CLELLAND, J.: "Parallel distributed processing". 2 vol. MIT Press, Cambridge, Mass., 1986
- RUSSELL, Bertrand: "Our knowledge of the external world(1914).- Allen & Unwin, London, 1961
- RUSSELL, Bertrand: "An inquiry into meaning and truth" (1940).- Allen and Unwin, London, 1966
- RUSSELL, W.M.S.: "Evolutionary concepts in behavioral science". SGSR Yearbook, 6, 1961
- RYAN, S. et al.: "The virtual university: the internet and resource based learning" - Kogan Page, London, 2000
- RYLE, Gilbert: "The Concept of Mind" - Barnes and Noble, New York, 1967
- SABAS, A. et al.: "A multi-agent system development methodology"- Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- SABATIER, Ph. et al.: "Fractals and epidemic process" - CASYS J., 1, Inst. de Math., Univ. de Liège, Belgium, 1998
- SABELLI, Hector: "Mathematical dialectics, scientific logic and the psychoanalysis of thinking", in Cohen, R.S. & Wartofsky, M.W. (eds): "Hegel and the sciences". Reidel, Dordrecht, 1984
- SABELLI, H. & CARLSON-SABELLI, L.: "Biological priority and psychological supremacy" - Amer. J. Psych., 146, 1989
- SABELLI, Hector C.: "Union of opposites: a comprehensive theory of natural and human processes". Brunswick Publ., Laurenceville, VA, 1989
- SABELLI, Hector C.: "Process theory, a biological model of open systems". 35th ISSS Meeting, Osterund, Sweden, 1991
- SABELLI, H. & CARLSON-SABELLI, L.: "Modular organization of human systems; a process theory perspective". Proc. 36th. ISSS Meeting, Denver, 1992
- SABELLI, H. & CARLSON-SABELLI, L.: "Process theory: energy, information and structure in the phase-space of opposites". Proc. 36th ISSS Meeting, Denver, 1992
- SABELLI, Hector C.: "Entropy as symmetry: theory and empirical support". 38th ISSS Meeting, Asilomar, 1994
- SABELLI, H. & CARLSON-SABELLI, L.: "Sociodynamics: The application of process methods to social sciences". Proc. Chaos & Society Conf., Univ. Quebec, Ottawa, 1994
- SABELLI, H. & KAUFFMAN, L.: "Mathematical physiology: a process theory of systems"- Proc. 42nd Conf. of ISSS, Georgia Technology Institute, Atlanta, 1998
- SABELLI, H. & CARLSON-SABELLI, L.: "Process thermodynamics and informational entropy"- Proc. 42nd Conf. of ISSS, Georgia Technology Institute, Atlanta, 1998
- SABELLI, Hector: "The union of opposites: from Taoism to process theory"- SRBVS, 18(5) 1998
- SACHE, Aimé: "La Theorie des Graphes". P.U.F., Paris, 1974
- SACHS, H.: "Einführung in die Theorie der endlichen Graphen". Teubner, Leipzig, 1972
- SACHS, W.M.: "Toward formal foundations of teleological systems science" - General Systems, XXI, 1976, 145-153
- SACHSSE, Hans: "Einführung in die Kybernetik". Rowohlt, Hamburg, 1974
- SADOVSKY, Vadim: "Foundations of General Systems Theory". Nauka, Moscu, 1974
- SADOVSKY, Vadim: "Problems of a General Systems Theory as a metatheory". Ratio, 16, (p.33-50), 1974
- SÄLLS, Pehr: "The possibility of the impossible (on the meaning of self-contradictory drawings)"- C&HK, 1(1), 1992
- SAEZ VACAS, Fernando: "A complexity architecture for information technologies". Syst. Practice, 3 (1) 1990
- SAFFARPOUR, Nima: "Multi-agent systems: a new field for system theory research?" - Proc. 15th Cybernetics & Systems Meet., Austr.Soc. for Cyb. Studies, Vienna, 2000
- SAGASTI, F. & MITROFF, I.I.: "Organizations Research from the viewpoint of General Systems Theory". Omega 1 (6) 1973
- SAGE, A. : "Methodology for large-scale systems" - McGraw Hill, New York, 1977
- SAGLIO, Philippe: "La communication chimique chez les poissons". La Recherche, nr. 248, nov. 1992
- SALNER, M.: "Adult cognitive and epistemological development in systems education" - Systems Research, 3 (4) 1986, p. 225-232
- SALTHER, Stanley N.: "Evolving hierarchical systems". Columbia Univ. Press, New York, 1985
- SALTHER, Stanley N.: "Self-organization of/in hierarchically structured systems". Syst. Research, 6 (3) 1989
- SALTHER, S.: "Development and evolution: complexity and change in biology" - Bradford/MIT Press, Cambridge, Mass.1993
- SALTHER, S. & MATSUNO, K.: "Self organization in hierarchical systems" - J. Evol. Syst. Res., 18, 1995
- SALTHER, Stanley: "Natural philosophy and developmental systems" -SRBVS, Vol. 18 (5), Sept.Oct.2001
- SALTHER, Stanley: "Entropy: what does it really mean?" - Gen. Syst. Bull., 32, 2003
- SAMARAS, G.H.: "Scientific research and social responsibility". ASC Cyb. Forum, VII (2) 1974
- SAMETBAND, Moises J.: "Entre el orden y el caos: la complejidad"- Fondo de Cultura Económica, Mexico, 1993
- SANDERSON, S.K.: "Social evolutionism" - Blackwell, Cambridge, 1990
- SANDOZ, Thomas C.: "Epistémologie du sujet, constructivisme et pensée". Proc. 2nd. Europ. Meet. on Systems Sciences, Praha, 1993
- SANKAR SANGUPTA, S. & ACKOFF, R. L.: "Systems theory from an O.R. point of view". SGSR Yearbook, 10, 1965
- SANSONNET, Jean P.: "L'architecture des nouveaux ordinateurs". La Recherche, nr.204, nov. 1988
- SANTAELLA BRAGA, Lucia: "Peirce and Biology"- Semiotica, 127(1/4) 1999
- SARBO, Janos J. et al.: "Meaning extraction from a Peircean Perspective" - CASYS J. , 6, Liège, Belgium, 1999
- SARGET, Marie-Noëlle: "Systemic analysis and its use in political sociology", in Banathy, B. & Rodriguez Delgado, R. (eds.): "Intern. Systems Science Handbook". Systemic Public., Madrid, 1993
- SATOURIS, Elizabeth: "Gaia: The human Journey from Chaos to Cosmos" - Pocket Books, New York, 1989
- SAUNDERS, P.T.: "An introduction to catastrophe theory". Cambridge Univ. Press, New York, 1980
- SAUSSURE, F. de: "Cours de Linguistique Générale"- Payot, Paris, 1916. "Course of General Linguistics" (W. Bastain, translator) Philosophical Library, New York, 1959
- SAUSSURE, F. de: "Grundfragen der Allgemeinen Sprachwissenschaft" 2 ed.- de Gruyter, Berlin, 1967
- SAYRE, K. & CROSSON, F. (eds): "The modelling of mind". Notre Dame Univ. Press, 1963
- SAYRE, Kenneth: "Cybernetics and the phenomenology of mind". Routledge & Kegan Paul, London, 1976 - or Humanities Press, Atlantic highlands, NJ, 1976
- SCANDELLA, Luigi: "Le Kondratieff: essai de théorie des cycles longs économiques et politiques"- Economica, Paris, 1998
- SCARROTT, Gordon G.: "The formulation of a science of Information" - C&HK, 5(4), 1998
- SCHACHTNER, Christel: "Geistmaschine" - Suhrkamp Taschenbücher, Frankfurt, 1993

- SCHAEFER, Gerhard: "Kybernetik und Biologie". Metzler, Stuttgart, 1972
- SCHAFFER, J.D. (Ed): "Proceedings of the 3rd International Conference on Genetic Algorithms" - Morgan Kaufmann, San Mateo, CA, 1989
- SCHANK, Roger C.: "De la mémoire humaine à la mémoire artificielle". La Recherche, nr.273, feb. 1995
- SCHAECHTER, Bruce: "Birds of a Feather" - N.Sc., Nr.2170, January 23th, 1999
- SCHAPER, W.G. & G.C.: "Autopsies on Autopoiesis". Behav. Science, 41 (1) 1996
- SCHAPER, William J. and Gert C.: "Autopsies on Autopoiesis". Behav. Science, 41 (1), 1996
- SCHIEMENZ, B.: "Regelungstheorie und Entscheidungsprozesse. Ein Beitrag zu Betriebskybernetik". Betriebswirtschaftlicher Verlag Th. Gabler, Wiesbaden, 1972
- SCHIEMENZ, B.: "Managing complexity by recursion". Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- SCHIEVE, W.C. & ALLEN, P.N. (eds): "Self-organization and dissipative structures". Univ. of Texas Press, Austin, 1982
- SCHILPP, P.A. (ed.): "Albert Einstein: philosopher and scientist". Open court, La Salle, IL., 1970
- SCHILPP, P.A.(ed.): "The philosophy of Karl Popper". - Open Court Publishers, 1974
- SCHILTZ, M. & VERSCHRAEGEN, G.: "Spencer-Brown, Luhmann and Autology". C&HK, 9(3-4) 2002
- SCHLIEBEN-LANGE, Brigitte: "Sozio-linguistik". Kohlhammer, Stuttgart, Berlin, 1973
- SCHMANDT-BESSERAT, Denise: "Before writing: from counting to cuneiform" (2 Vol) -Univ. of Texas Press, Austin, TX, 1992
- SCHMANDT-BESSERAT, Denise: "Counting, accounting and abstraction". Proc. 42nd ISSS Conf., Atlanta, 1998
- SCHMIDT, J.: "Die sanfte Organisationsrevolution. Von der Hierarchie zu selbststeuernden Systemen". Campus Verlag, Frankfurt, New York, 1993
- SCHMIDT, Karen: "The big catch; an application of the Bayesian probabilities to the evaluation of fish stocks" - N. Sc., 2387, March 22, 2000
- SCHMIDT, Siegfried (ed.): "Der Diskurs des Radikalen Konstruktivismus" - Suhrkamp, Frankfurt, 1987
- SCHMITZ, W. & SEBEOK, Th.A.(eds.): "Semiotik-Strukturalismus: das Erbe einer universalen Wissenskulturs" - Universitätsverlag, Dresden, 2000
- SCHÖN, Donald A.: "Displacement of concepts"- Tavistock, London/Humanities Press, New York, 1963
- SCHÖN, Donald A.: "Beyond the stable state"- Random House, New York, 1971
- SCHÖN, Donald A.: "Organization learning (in G. MORGAN (ed.): Beyond method"- Sage, Beverly Hills, 1973
- SCHÖN, Donald A.: "The reflective practitioner"- Basic Books, New York, 1983
- SCHÖN, Donald A.: "Educating the reflective practitioner: toward a new design for teaching and learning"- Jossey-Bass, San Francisco, CA, 1987
- SCHÖN, Donald A.: "The reflective turn: case studies in and on educational practice"- Teachers College, New York, 1991
- SCHÖN, Donald A. & REIN, M.: "Frame reflection: toward resolution of untractable controversies"- Basic Books, New York, 1994
- SCHOENFELD, Robert L.: A review of Raymond M. Smullyan's "Gödel's incompleteness theorem". Amer. Scientist, 82 (1) Jan./feb. 1994
- SCHOLZ, C.: "OR/MS methodology: a conceptual framework". Syst. Research 4 (2) 1987
- SCHOUTEN, J.F.: "On the concepts of endechy and manipulation". Synthèse, 9 (3) 1953
- SCHRAMM, Wilbur (Ed.): "The process and effects of mass communication". Univ. of Illinois Press, Urbana, 1960
- SCHROEDER, M.R.: "Fractals, chaos, power laws" - Freeman, New York, 1991
- SCHRÖDINGER, Erwin: "What is life?". Cambridge, London, 1945
- SCHUH, K. & MOHAMMED, M.A.: "Opportunity initiated systems design"- SPAR, 15(5) 2002
- SCHULTZ, D. & SCHULTZ S.E.: "Theories of personality" - Brooks/Cole Publ.Co., Pacific Grove, CA, 1994
- SCHUMPETER, Joseph A.: "Business cycles: a theoretical, historical and statistical analysis of the capitalistic process" - McGraw Hill, New York, 1939
- SCHUMPETER, Joseph: "Capitalisme, Socialisme et Démocratie" - Payot, Paris, 1954. Original: "Capitalism, Socialism and Democracy" - Allen & Unwin, London, 1942
- SCHUSTER, H.G.: "Deterministische Chaos". Springer, Berlin, 1985
- SCHUSTER, Peter: "How does complexity arise in evolution?" - Santa Fe Inst. Working Papers, nr.96-05-026
- SCHUTZ, A.: "The phenomenology of the social world"- Heinemann Educational Books, London, 1967
- SCHUTZENBERGER, M.P.: "A tentative classification of goal seeking behaviors", in Emery, F. (ed.): "Systems Thinking". Penguin, Harmondsworth, 1969
- SCHWANINGER, Marcus: "Integrale Unternehmensplanung"- Campus, Frankfurt a/M, New York, 1989
- SCHWANINGER, Marcus: "Management Systeme"- Campus, Frankfurt a/M, 1994
- SCHWANINGER, Marcus: "Organizational intelligence: the ecological dimension" - 42nd Conference of ISSS, Georgia Technology Institute, Atlanta, 1998
- SCHWANINGER, Marcus: "Managing complexity: the path toward intelligent organization"- SPAR, 13 (2) 2000
- SCHWANINGER, Marcus: "Intelligent organizations: an integrative framework" - SRBVS, 18(2), 2001
- SCHWANINGER, Marcus: "Transdisciplinarity in management, education and research: some evidences of the contribution of systems theory and cybernetics"- Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- SCHWARTZ, P.: "The art of long view"- Currency Doubleday, San Francisco, 1991
- SCHWARZ, Eric: "La Révolution des Systèmes". Del Val, Cousset (Fribourg), Suisse, 1988
- SCHWARZ, Eric: "Quelques remarques épistémologiques (entre autres) sur l'approche systémique", in "La systémique en tant que nouvelle forme de connaissance". Institut de la Méthode, symp. écrit, nr.3, Bienne, 1990
- SCHWARZ, Eric: "A generic model for the emergence and evolution of natural systems toward complexity and autonomy" Proc. 36th Meet.ISSS, Denver, 1992
- SCHWARZ, Eric: "From models of being to modes of being: a model for consciousness". Proc. 36th ISSS Meeting, Denver, 1992
- SCHWARZ, Eric: "Un modèle générique de l'émergence, de l'évolution et du fonctionnement des systèmes naturels vivants". Inst. de la Méthode, Symp. écrit, nr.17, Bienne, 1994 (in English in Proc. 36th ISSS Meeting, Denver, 1992)
- SCHWARZ, Eric: "Glossaire systémique", Univ. de Neuchâtel, 1993
- SCHWARZ, Eric: "Glossaire systémique" - Université de Neuchâtel, 1993
- SCHWARZ, Eric: "From models of being to modes of being: a model for consciousness". 38th ISSS Meeting, Asilomar, 1994
- SCHWARZ, Eric: "Un modèle générique de l'émergence, de l'évolution et du fonctionnement des systèmes naturels viables"- 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- SCHWARZ, Eric: "Control in non-artificial systems: where does it come from?" - Proc. of the 14th Internat. Congr. Cyb., Namur, Belgium, 1995
- SCHWARZ, Eric: "About the possible convergence between science and spirituality"- C&HK 4(4) 1997
- SCHWARZ, Eric: "Toward a holistic cybernetics".- C&HK., 4 (1), 1997
- SCHWARZ, Eric: "Seven steps in the general evolution of systems"- Systems, 3(1), Technological Univ. Wroclaw, Poland 1998
- SCHWARZ, Eric: "The evolution of anticipation: a systemic holistic view" - CASYS J., 2, Inst.Mathém., Univ. de Liège, 1998
- SCHWARZ, Eric: "A review of D. Bohm and B.J. Hilley's book: The undivided universe"- SPAR, 12 (1) 1999
- SCHWARZ, Gerhard: "Konfliktmanagement. Konflikte erkennen, analysieren, lösen" - (4te. Aufgabe) - Gabler, Wiesbaden, 1999
- SCHWEMMLER, Werner: "Reconstruction of cells evolution. A periodic system" - CRC Press, Boca Raton, FL, 1984
- SCHWEMMLER, Werner: "Symbiogenesis: a macro-mechanism of evolution"- De Gruyter, Berlin, 1989
- SCHWEMMLER, Werner: "Symbiogenese als Motor der Evolution: Grundriss einer theoretischen Biologie"- Paul Parey, Berlin, 1991
- SCIENCE: "Complex systems": A special issue including 10 papers, mainly on complexity in physical sciences.- Science, 284, Apr. 2, 1999
- SCIENTIA (Journal): "Prigogine's epistemology: an overview". Scientia, 117 (1-4), Milano, 1982 (with transl. in Italian)
- SCOTT, A.: "Stairway to the mind: the controversial science of consciousness" - Springer Verlag, Ijmuiden, Netherlands, 1995
- SCOTT, Bernard: "Cybernetics and the social sciences"- SRBVS 18(5), Sept.-Oct., 2001
- SCOTT, B. & GLANVILLE, R. (eds.): Gordon Pask, remembered and celebrated (Parts I and II)- Kybernetes, 30 (5-6); (7-8), 2001
- SCOTT, George P. (ed): "Time, rythms and chaos in the new dialogue with nature". Iowa State Univ. Press, Ames, 1991
- SCUDDER, Charles L.: "The mind: An evolving system of models" Fields within fields, nr. 14, 1975

- SCUR, G.S.: "Some considerations on the notion of invariant fields in linguistics". *SGSR Yearbook*, 10, 1965
- SEARLE, John: "Speech acts" - Cambridge Univ. Press, Cambridge, MA., 1969
- SEARLE, John: "What is a speech act?" - in GIGLIOLI, P.P. (ed.): "Language and Social Context" - Penguin Books, Harmondsworth, Middlesex, England, 1972
- SEARLE, John R.: "Expression and meaning: studies in the theory of speech acts" - Cambridge Univ. Press, Cambridge, England, 1979
- SEARLE, John R.: "Intentionality; an essay on the philosophy of the mind" - Cambridge University Press, Cambridge, Mass., 1983
- SEARLE, John: "Minds, Brains and science" - Penguin, Harmondsworth, UK, 1989
- SEARLE, John R.: "The rediscovery of the mind" - The MIT Press, Cambridge, MA, 1992
- SEARLE, John R.: "The construction of social reality" - Free Press, New York, 1995
- SEARLE, John R.: "The mystery of consciousness" - New York Review of books, New York, 1997
- SEARLE, John R.: "Mind, language and society: philosophy in the real world" - Basic Books, New York, 1998
- SEBEOK, Thomas: "Perspectives in zoosemiotics" - Mouton, The Hague, 1972
- SEBEOK, Thomas: "The sign and its masters" - Univ. of Texas Press, Austin, TX, 1979
- SEBEOK, Thomas: "Sight, sound and sense" - Indiana Univ. Press, Bloomington, 1981
- SEBEOK, Thomas: "Encyclopedic Dictionary of Semiotics" (3 vols.) - Mouton de Gruyter, Berlin, 1986
- SEBEOK, T. & UMIKNER-SEBEOK, J.(eds.): "Biosemiotics: the semiotic web" - Mouton de Gruyter, Berlin, 1992
- SEBEOK, Thomas: "Signs: an introduction to semiotics" - Univ. of Toronto Press, 1994
- SEBEOK, T.A. & DANESI, Marcel: "The forms of meaning: modeling systems theory and semiotics" - Mouton, De Gruyter, Berlin, 2000
- SEELEY, Thomas: "The honeybee colony as a super-organism". *Amer. Scientist*, 77 (6) 1989
- SEELEY, Thomas: "The Wisdom of the Hive: The social physiology of honeybees colonies" - Harvard Univ. Press, Cambridge, Mass., 1995
- SEIDEN, D. & SABELLI, H.: "Co-creation: a process theory of form in art and life". *Proc. 36th ISSS Meeting*, Denver, 1992
- SEIF, Farouk Y.: "Semiotic systems and built environments" *Proc. 36th ISSS Meeting*, Denver, 1992
- SELSKY, H. & BARTON, J. (eds.): "Sources and legacy of EMERY's open systems theory" - *SPAR*, 13(5) 2000
- SELYE, Hans: "Histoire du syndrome général d'adaptation" - Gallimard, Paris, 1954 (Original: The story of general adaptation syndrome)
- SELYE, Hans: "The stress of life". McGraw Hill, New York, 1975
- SEMETSKI, Inna: "Signs in action: tarot as a self-organized system" - *C&HK*, 8, (1-2), 2001
- SENDZIMIR, J. & ODUM, H.: "Limits to memory in ecosystems and society" - 42nd Conference of ISSS, Georgia Technology Institute., Atlanta, 1998
- SENGE, Peter: "The fifth discipline" - Doubleday, New York, 1990
- SENGUPTA, K. & TE'ENI, D.: "Cognitive feedback in group decision support systems" - *MIS quarterly*, 1994
- SERGIN, V. Ya.: "Self identification as key mechanism of awareness" - *Proc. 14th Meet. on cybernetics and Systems*, Vienna, 1998
- SERRA, R. & ZANARINI, G.: "Complexity in natural and cultural systems". *Syst. Research*, 4 (2) 1987
- SERRA, R. & ZANARINI, G.: "Complex systems and cognitive processes" - Springer, Berlin, 1990
- SERRA, R.: "Applying systems science to environmental rehabilitation" - 1st. Italian Conference on Systemics. Apogeo, Milano, 1998
- SERTORIO, L.: "Thermodynamics of complex systems" - World Scientific, Singapore, 1991
- SEWELL, G.L.: "Quantum theory of collective phenomena". - Oxford Univ. Press, Oxford, 1986
- SHALBIK, Martin: "Simulation of socio-economic systems". *SGSR Yearbook*, 12, 1967
- SHANNON, C. & WEAVER, W.: "The mathematical theory of communication". Univ. of Illinois Press, Urbana, 1949
- SHANNON, C.: "Prediction and entropy in printed English". *The Bell Syst. Techn. J.*, 30, 1951
- SHANNON, C.: "A universal Turing machine with two internal states", in "Automata Studies". Princeton Univ. Press, 1956
- SHANNON, R.E.: "System simulation" - Prentice Hall, Englewood Cliffs, N.J., 1975
- SHANON, Benny: "Metaphors for language and communication". *Rev. Intern. de Systémique*, 3 (1) 1989
- SHAPIRO, J.H.: "Bacteria as Multi-cellular Organisms" - *Sc. Amer.*, Vol.258, 6, p.82-89, 1988
- SHCHEDROVITZKY, G.P.: "Methodological problems of systems research". *SGSR Yearbook*, 11, 1966
- SHEETS-JOHNSTONE, M.: "Consciousness: a natural history" - *J. of Consciousness Studies*, 5(3), 1998
- SHELDRAKE, Rupert: "A new science of life: the hypothesis of formative causation". J.P. Tarcher, Los Angeles, 1982
- SHELDRAKE, Rupert: "Seven experiments that could change the world" - Riverhead Books, New York, 1995
- SHERMAN, Howard J.: "The business cycle: growth and crisis under capitalism" - Princeton Univ. Press, Princeton, N.J., 1992
- SHERMER, Michael: "The crooked timber of history" - *Complexity*, V.2, Nr.6, 1997
- SHRIVASTAVA, P. & MITROFF, I.: "Enhancing organizational research utilization: the role of decision maker's assumptions". *Acad. Man. Rev.* 9, 1984
- SIEGEL, H.: "Naturalized epistemology and "first philosophy" - *Metaphilosophy*, 26 (1/2) p. 46-62, 1995
- SIEGELMANN, H.: "Neural networks and analog computation: beyond the Turing limit" - Birkhauser, Boston, 1999
- SIEGWART, H. & PROBST, G.(eds.): *Mitarbeiterführung und gesellschaftlicher Wandel* - Haupt, Bern, Stuttgart, 1983
- SIETROV, M.I.: "Myths and fetishes of the General Systems movement". *Cyb. & Systems*, 20 (3) 1989
- SIGART: "Integrated cognitive architecture". *SIGART*, 2 (4), Kluwer, Delft, 1991
- SIGHELE, Scipio: "Le folle criminale". Roma, 1892
- SILJAK, Dragoslav D.: "Large scale dynamic systems". Elsevier North Holland, Amsterdam, 1978
- SILVERMAN, D.: "The theory of organizations" - Heinemann, London, 1970
- SILVERMAN, Irving: "System theory and the unity of knowledge". *Cyb. & Systems*, 23 (2) 1992
- SIMMS, James R.: "Living systems theory, information and knowledge" - 42nd. Conference of ISSS, Georgia Technology Institute, Atlanta, 1998
- SIMON, E.: "Distributed Information Systems" - McGraw Hill, Maidenhead, UK., 1997
- SIMON, Herbert: "Models of man". Wiley, New York, 1957
- SIMON, Herbert: "Note on a departamental identification of executives". *Sociometry*, 21, pp.140-44, 1958
- SIMON, Herbert: "The architecture of complexity". *SGSR Yearbook*, 10, 1965
- SIMON, Herbert: "Rational choice and the structure of the environment", in Emery, F.E. (ed): "Systems Thinking". Penguin, Harmondsworth, 1969
- SIMON, Herbert: "The science of the artificial". MIT Press, Cambridge, Mass., 1969
- SIMON, Herbert: "The structure of ill-structured problems". *Artif. Intelligence*, 4 (p.181-201), 1973
- SIMON, Herbert: "How big is a chunk?". *Science*, 183, 1974
- SIMON, Herbert: "Models of discovery". Reidel, Boston, 1977
- SIMON, Herbert: "Sur la complexité des systèmes complexes". *Rev. Intern. de Systémique*, 4 (2) 1990 (translation of "Systemics and complexity". The Philosophy of Science Association, 2, 1977)
- SIMON, H.A.: "Models of bounded rationality" - MIT Press, Cambridge, MA, 1997
- SIMON, Joseph: "Philosophy of the sign" - Albany, N.Y., 1995
- SINAI, Yakov G.: "L'aléatoire du non-aléatoire", in Dahan Dalmedico, A. et al.: "Chaos et déterminisme". Le Seuil, Paris, 1992
- SINGER, Alan E.: "Strategic Thinking without Boundaries". *Syst. Practice* 9 (5), 1996 (on pluri-rationality and metadecisions)
- SINGER, David L.: "A General Systems taxonomy for political sciences". Sage, Beverly Hills, 1971
- SINGER, P.: "How are we to live: ethics in an age of self-interest" - Mandarin, Melbourne, 1995
- SINGH, Jagjit: "Great ideas in information theory, language and cybernetics". Dover, New York, 1966 (in Spanish: "Teoría de la información, del lenguaje y de la cibernética". Alianza, Madrid, 1972)
- SINGH, Jagjit: "Operations research". Doer, New York, 1968
- SIPPER, M.: "Evolution of parallel cellular machines" - Springer, Berlin, 1997
- SIPPER, M. & REGGIA, J.A.: "Go forth and replicate" - *Sc. Amer.*, Vol. 265(2), Aug. 2001
- SIRGY, M.J. & GILES, R.H. Jr.: "Succession - an alternative to product life cycle". *Syst. Research*, 3(4) 1986
- SIRGY, M.J.: "Self-congruity: toward a theory of personality and cybernetics". Praeger, New York, 1986
- SIRGY, M.J.: "Two hierarchical dimensions of research concepts". *Syst. Research*, 5 (2) 1988

- SIRGY, M.J. & MANGLEBURG, T.F.: "Toward a General Systems Theory of development". *Syst. Research*, 5 (2) 1988
- SITEK, Wojciech: "Sociological research as the examination of social systems (on F. Znaniecki)" - *Systems*, 4(1-2) Polytechnical Univ., Wroclaw, Poland, 1999
- SKINNER, B.F.: "Behavior of organisms" - Appleton, Century, Crofts, New York, 1938
- SKITTNER, Lars: "General Systems Theory" - Macmillan, London, 1996
- SKITTNER, Lars: "The future of systems thinking" - *SPAR*, 11(2) 1998
- SKOLIMOWSKI, H.: "Eco-philosophy versus the scientific world view" - *Ecologist Quarterly*. Aut. 1978, p. 227-248
- SKOLIMOWSKI, H.: "The participatory mind" - Penguin, London, 1994
- SKYTNER, Lars: "The general rescue subsystem: adaptation and structure at sea". *Syst. Research*, 9 (2) 1992
- SLATER, P.J. & HALLIDAY, T.R.: "Behavior and evolution" - Cambridge Univ. Press, New York, 1994
- SLAWSKI, Carl: "Social e-Co-Realization: a biospherical ideal of syntropic wisdom" - *Proc. 42nd ISSS Conf.*, Atlanta, 1998
- SLAWSKI, Carl: "Social psychological theories; maps and stars" - Cypress, CA, 1998
- SLAWSKI, Carl: "Triangulating levels of true theory: earth and global societal sustainability" - *Proc. 42nd ISSS Conf.*, Atlanta, 1998
- SLOBODCHIKOFF, C.N. (ed.): "The ecology of social behavior" - Academic Press, San Diego, 1988
- SLOBODKIN, L.B.: "Animal populations and ecologies", in Milsom, John (ed): "Positive feedback". Pergamon, New York, 1968
- SLOBODKIN, L.B.: "The strategy of evolution". *Amer. Scientist*, 52, 1974
- SLOTINE, Jean- Jacques: "A l'heure des neurosciences" - *La Recherche*, nro.350, fevr.2002
- SLUCKIN, W.: "Minds and machines". Penguin, Harmondsworth, 1954
- SLUZKI, Carlos E.: "The Eigen-value of stories" - *C&HK*, 3(3), 1995
- SMALE, S.: "The mathematics of time". Springer, New York, 1980
- SMELSER, N.J.: "Social change in the industrial revolution" - Univ. of Chicago Press, Chicago, 1959
- SMELSER, N.J.: "Essays in sociological explanation" - Prentice Hall, Englewood Cliffs, NJ, 1968
- SMITH, Cyril: "The shape of things". *Sc. American*, 190, 1964
- SMITH, Charles: "Transformation and regeneration in social systems: a dissipative structure perspective". *Syst. Research*, 3 (4) 1986
- SMITH, E.R. & MACKIE, D.M.: "Social Psychology" - Worth Publishers, New York, 1995
- SMITH, John Maynard & SATHMARY, Georg: "The origins of life" - Oxford Univ. Press, 1999
- SMITH, L.B. & THELEN, E.: "A dynamic systems approach to the development of cognition and action" - MIT Press, Cambridge, MA, 1994
- SMITH, Robert, A. III: "Synergistic organizations". *Fields within fields*, V.3, nr.1, 1970
- SMITH, T.: "Value theory and dialectics" - *Science and society*, 62 (3) 1998
- SMITH, William E.: "Wholeness: dimensions of power" - *SPAR*, 12(4) 1999
- SMUTS, Jan: "Holism and evolution". Greenwood Press, Westport, Conn., 1973 (Orig. edit., McMillan, London, 1926)
- SMYTH, D. & CHECKLAND, P.: "Using a systems approach: The structure of root definitions". *J. Appl. Syst. Anal.*, 5, 1976
- SNEAD, K. jr. & NDEDE-AMADI, A.A.: "Attributional bias as a source of conflict between users and analysts" - *SPAR*, 15(5) 2002
- SNEATH, P.H.A. & SOKAL, R.R.: "Numerical Taxonomy". Freeman, San Francisco, 1973
- SNELL, James L.: "Design of the modern inquiring systems: IV: Warren S. McCulloch (1898-1969)". *Syst. Research*, 5 (4) 1988
- SNOW, Roberta M.: "The integration of systemic and interpretative thought", in Banathy, B. & Rodriguez Delgado, R. (eds.): "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- SNYDER, L.: "Hypertext: the electronic labyrinth" - Melbourne Univ. Press, Carlton South, Australia, 1996
- SOBER, Elliot & WILSON, D. Sloan: "Unto others" - Harvard Univ. Press, 1998
- SOKAL, A. & BRICMONT, J.: "Impostures intellectuelles" - Odile Jacob, Paris, 1997.
- SOKAL, A. & BRICMONT, J.: "Fashionable nonsense: postmodern intellectuals abuse of science" - St. Martin Press, New York, 1998
- SOKAL, Robert R.: "Numerical Taxonomy", in R. CAMP et al.: "Mathematical Thinking in Behavioral Sciences". Freeman, San Francisco, 1968
- SOKAL, Robert R.: "Classification: purposes, principles, progress, prospects". *Science*, sept.27, 1974
- SOLARI, S.: "From optimization to viability: a systemic view of economic policy" - 1st. Italian Conf. on Systemics, Apogeo, Milano, 1998
- SOLE, R. & GOODWIN, B.: "Signs of life: how complexity pervades biology" - Basic Books, New York, 2000
- SOLER, Léna: (A review of Elie Hazar's "Essai d'épistémologie") - *La Recherche*, nro.348, déc. 2001
- SOMMER, Hanns: "Knowledge processing in an anticipatory and a non-anticipatory mode" - *CASYS J.*, 6, Liège, Belgium, 1999
- SOMMERHOFF, G.: "The abstract characteristics of living systems", in Emery, F.E. (ed): "Systems Thinking". Penguin, Harmondsworth, 1969
- SONNTAG, Jean- Paul: "Les Chryzodes" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- SOROKIN, Pitirim: "Social and cultural dynamics" - Porter Sargent, Boston, 1957
- SOROS, George: "The crisis of global capitalism: open society endangered" - Public Affairs, New York, 1998
- SOUDJIN, Karel: "Creative distortions and improvements" - *SRBVS*, 19(2) 2002
- SOWA, John F.: "Conceptual structures" - Addison Wesley, Reading, MA, 1984
- SPARROW, C.: "The Lorenz Equations: Bifurcations, Chaos and Strange Attractors" - Springer, New York, 1982
- SPEARMAN, C.: "The nature of intelligence" and the principles of cognition" - Macmillan, London, 1923
- SPEISER, Ambros: "Die Wechselwirkung von Forschung und technischem Wandel" - *Neue Zürcher Zeitung*, nr. 159 (12/13 Juli 1997)
- SPENCER-BROWN, G.: "Laws of form". Dutton, New York, 1979
- SRAMO, Andras: "IT environment of decision-making in Hungary" - *Proc. 9th IDIMT*, Zádov, Universitätverlag R. Trauner, Linz, 2001
- SRISKANDARAJAH, N. & BRIER, S.: "Reflective practice in learning and research: a special issue on the Hawkesbury Western Sidney University conference (Australia)" - *C&HK*, 7(4) 2000
- STACEY, R. D.: "Managing Chaos: Dynamic Business Strategies in a Unpredictable World" - Kegan Paul, London, 1992
- STACEY, R.: "Managing the unknowable: strategic boundaries between order and chaos in organizations" - Jossey Bass, San Francisco, 1992
- STACEY, R.: "Strategy as order emerging from chaos" - *Long Range Plan*, 28, 1993
- STACEY, R.: "Strategic management and organizational dynamics" - Pitman, London, 1996 a
- STACEY, R.: "Complexity and creativity in organizations" - Berrett-Koehler, San Francisco, 1996b
- STACHOWIAK, H.: "Allgemeine Modelltheorie" - Springer, Vienna, 1973
- STAMPS, Jeffrey L.: "Holonomy: A human systems theory". Intersystems, Seaside, CA, 1980
- STANLEY-JONES, D. & K.: "The Cybernetics of natural systems: A study in patterns of control". Pergamon, New York, 1960
- STAPP, H.: "Matter, mind and quantum mechanics" - Springer Verlag, New York, 1993
- STARKERMAN, R.: "Greater than the sum of its parts" - *Proc. 10th Cybernetics and Systems Conference*, Bucharest, 1996
- STARKERMAN, R.: "Unity is strength: from 'Viribus Unity' to 'Corruptio'" - *Proc. 42nd ISSS Conf.*, Atlanta, 1998
- STEELS, Lucien: "Cooperation between distributed agents through self-organization". in Intern. Workshop on Intelligent robots & systems, Proceed. IEEE-IROS'90, 1990
- STEELS, Lucien: "Robots and the origin of intelligence" - 13th Meet. on Cybernetics and Systems, Vienna, 1996
- STEELS, Lucien: "The synthetic modeling of language origins" - *Evol. of Communicat.*, 1, 1997
- STEELS, Lucien: "Mieux comprendre les hommes" - *La Recherche*, nro. 350, fev. 2002
- STEER, N.: "Knowledge societies" - Sage, London, 1994
- STEFFE, L.P. & THOMPSON, P. (eds.): "Radical constructivism in action" - Falmer Press, Washington, D.C., 1996
- STEIER, D. & MITCHELL, T.M. (eds.): "Mind matters" - L. Erlbaum, Mahwah, N.J., 1996
- STEIER, Frederick(ed.): "Research and reflexivity" - Sage, London, 1991
- STEIER, Frederick: "Cybernetics as...mutuallig" - *C&HK*, 1(2/3) 1992
- STEIER, Frederick: "Dialogue and 2nd order cybernetics: a mutual affinity" - *C&HK*, 5(3) 1998
- STEIER, F. & OSTRENKO, W.: "Taking cybernetics seriously at a science center" - *C&HK*, 7(2-3) 2000

- STEINBUCH, Karl: "Die Lernmatrix". Kybernetik, I, 1961. (See also P. Müller, in N. Wiener & J.P. Schädé (eds): "Nerve, brain and memory models". Elsevier, Amsterdam, 1963)
- STEINBUCH, Karl: "Automat und Mensch". Springer, Berlin, 1971
- STEINBUCH, Karl: "Kurskorrektur"- DVT, München, 1974
- STEINER, E. & REITER, L.: "Family therapy, therapy research, and the theory of self-referential systems", in Dalenort, G.J. (ed.): "The paradigm of self-organization". Gordon & Breach, New York, 1989
- STEINER, G.: "Grammatik der Schöpfung"- Hanser, München, 2001
- STEKNER, Cornelius A.: "Anticipatory Maps" - CASYS J., 3, Inst. de Mathém., Univ. de Liège, Belgium, 1999
- STERLING, Leon S. (ed.): "Intelligent systems: concepts and applications" - Plenum Publishers, New York, 1993
- STERMAN, John D.: "Long wave decline and the politics of depression"- MIT Press, Cambridge, MA, 1992
- STEWART, Ian; ANDREEWSKY, E. & ROSENTHAL, V.: "Du Culte de l'Information en Biologie et en Sciences du Langage". Rev. Intern. de Systémique, 2, 1988
- STEWART, Ian: "Does God play dice? The Mathematics of Chaos" - Blackwell, Cambridge, Mass., 1989
- STEWART, Ian: "Portrait of Chaos". New Scientist, Nov.4, 1989
- STEWART, Ian: "The new mathematics of chaos" - Penguin Books, Harmondsworth, 1990
- STEWART, Ian: "Where do nature's patterns come from". New Scientist, Aug. 22, 1992
- STEWART, Ian: "The Synchronicity of Firefly Flashing" - Sc.Amer., March 1999
- STEWART, John & ANDREEWSKY, E.: "From information to autonomy: between biology and the language sciences". Kybernetes, 21 (5) 1992
- STICKLAND, Fr. & REAVILL, L.P.: "Understanding the nature of system change: An interdisciplinary approach". Syst. Research, 12 (2) 1995
- STICKLAND, F.: "The nature of dynamics and change"- City University, London, 1995
- STINCHCOMBE, Arthur: "Constructing social theories". Harcourt Brace & World, New York, 1968
- STJERNFELD, Frederick: "The idea that changed the world(on BEACON's Symbolic Mind)"- C&HK, 7(1) 2000
- STOLTERMAN, Erik: "Guidelines or aesthetics: two ways to approach the education of designers". Proc. 36th ISSS Meeting, Denver, 1992
- STONIER, Tom: "Information and meaning: an evolutionary approach" - Springer, New York, 1997
- STOWELL, Frank A.: "Systems science: addressing global issues". Plenum Press, New York, 1993
- STOWELL, F.A. et al.(eds.): "Systems sciences: addressing global issues"- Plenum Press, New York, 1993
- STOWELL, F.A. & WEST, D.: "Client-led design: a systemic approach to Information Physics" - McGraw Hill, London, 1994
- STOWELL, F.A. (ed.): "Information system provision: the contribution of Soft Systems Methodology"- McGraw Hill, London, 1995
- STOWELL, F.A. et al. (Eds): "Systems for Sustainability" - Plenum Press, New York, 1997
- STOWELL, F.A.: "The changing concept of Information Systems"- Proc. 6th IDIMT Conference, Zádov, Universitätverlag R. Trauner, Linz, 1998
- STOWELL, F.A.: "Concepts and practice in IS development"- Proc. 7th IDIMT, Zádov, Universitätverlag R. Trauner, Linz, 1999
- STRAUSSFOGEL, Debra & LARSEN BECKER, Mimi: "An Evolutionary Systems Approach to Policy Intervention for Achieving Ecologically Sustainable Societies". Syst. Practice 9 (5), 1996
- STRIJBOS, Sytse: "Systems thinking and the disclosure of a technological society: some philosophical reflections"- SRBVS, 20(3) 2003
- STROGATZ, Steven H. & STEWART, Ian: "Coupled oscillators and biological synchronization". Sc. American, 269 (6) 1993
- STRUNZ, Kurt: "Integrale Anthropologie und Kybernetik". Quelle & Meyer, Heidelberg, 1965
- STULMAN, Julius: "Fields within fields within fields". World Inst. Council, New York, 1968 on...
- STULMAN, Julius: "Beyond Crises: A Creative ladder for oncoming generations". Fields within fields, V3 (1) 1970
- STULMAN, Julius: "The methodology of pattern". Fields within fields, V5 (1) 1972
- STUMPFER, J. & RYAN, T.: "The development of systems thinking in South Africa"- SRBVS, 17(4) 2000
- STYLIOS, Chrysostomos D.: "Fuzzy cognitive maps for modeling complex systems"- Proc. 16th Meet. on Cyb. & Syst., Vienna, 2002
- SUAREZ, Roldan T.: "An inquiry into the historical meaning of the "5th discipline"- SPAR, 11(5) 1998
- SUAREZ, Roldan T.: "The holistic sense of prison phenomena in Venezuela: II. Toward a profound unveiling of the "Background"- SPAR, 12(1) 1999
- SUCHMAN, L.A.: "Plans and situated action: the problem of human-machine communication" - Cambridge, Univ. Press, Cambridge, U.K., 1987
- SUNDBERG, Lennart: "A holistic approach to competence development"- SRBVS, 18(2) 2001
- SUNDEL, Martin: "A Social Systems Approach to Improve Mental Health, Collaboration and Ethnic Relations in Cyprus" - SRBVS, Vol.16, Nr.5, 1999
- SUPPE, Frederic (ed.): "The structure of scientific theories". Univ. of Illinois Press, Urbana, 1974
- SUPPE, Frederick: "A review of Zeigler, B.P.: "Theory of modelling and simulation". Intern. J. Gen. Systems, 4 (2) 1978
- SUSHIL : "Situation-actor-Process options: mapping and enhancing flexibility"- SRBVS, 17(3) 2000
- SUSSMANN, M.: "Growth and development". Prentice Hall, New Jersey, 1964
- SUTHERLAND, John W.: "A general systems philosophy for the social and behavioral sciences". Braziller, New York, 1973
- SUTHERLAND, John W.: "Beyond behaviorism and determinism". Fields within fields, nr. 10, 1973-4
- SUTHERLAND, John W.: "Attacking organizational complexity". Fields within fields, nr.11, 1974
- SUTHERLAND, John W.: "Toward an array of phenomenological ideal types for the social sciences". Intern. J. Gen. Systems, 1 (2) 1974
- SUTHERLAND, John: "Holographic neural technology systems and applications" - CASYS J., 7, Inst. of Math., Univ. of Liège, Belgium, 2000
- SUTHERLAND, Stuart: "Can a machine see red?". New Scientist, nr. 1998, Oct. 7, 1995
- SVOBODA, Antonio: "Synthesis of logical systems of given activity". Transac. IEEE, EC 12, 1963
- SVOBODA, Antonio: "Behavior classification in digital systems". Inform. Proc. Mach., 10, 1964
- SWANN, P.: "Technology evolution and the rise and fall of industrial clusters". Rev. Intern. de Systémique, 10 (3) 1996
- SWANSON, G.A. & MILLER, J.G.: "Accounting information systems in the framework of living systems theory and research" - Systems Research, 3 (4), 1986, p. 253-266
- SWANSON, C.P.: "Ever-expanding horizons: the dual informational source of human evolution". Univ. of Massachusetts, Amherst, MA, 1983
- SWANSON, G.A.: "Building ISSS success, one failure at a time (a presidential address)" - Systems 2(2), Technical Univ., Wroclaw, Poland, 1997
- SWANSON, G.A. et al.: "Entropy, social entropy and money: a living systems theory perspective"- SRBVS, 14(1) 1997
- SWANSON, G.A.: "A world on the edge: is the new supranatural system propelling the world towards socioeconomic chaos?"- Proc. 42nd ISSS Conf., Atlanta, 1998
- SWANSON, G.A.: "Money information and wealth knowledge (in the Supra National System)- Systems 5(1/2) Polytechnical Univ. Wroclaw, Poland, 2000
- SWANSON, G.A.: "Management observation and communication theory and organization Information"- SRBVS, 18(5) 2001
- SWEETSER, E.: "From etymology to pragmatics: the mind-as-body metaphor in semantic structure and semantic change" - Cambridge Univ. Press, Cambridge, MA., 1990
- SWENSON, Rod: "Emergent attractors and the law of maximum entropy production: Foundation for a theory of general evolution". Syst. Research, 6 (3) 1989
- SWENSON, Rod: "Order, evolution and natural law", in Negoita, C.V.(ed.): "Cybernetics and applied systems" - M.Dekker, New York, 1992
- SZANTO, Boris: "Socio-technical functioning and anthropogenic crises"- SRBVS, 15(4) 1998
- SZILARD, Leo: "Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen". Zeitschrift für Physik, 53, 1929
- TABARY, J.C.: "Interface et assimilation; état stationnaire et accommodation". Rev. Intern. de Systémique, 3 (3) 1989
- TABARY, J.C.: "Commentaires sur l'article de F. Bon-sack" in "La systématique en tant que nouvelle forme de connaissance" Institut de la Méthode, Bienne, 1991
- TABARY, J.C.: "Perception et autonomie". Institut de la Méthode, Symp. écrit, nr.14, Bienne, 1994
- TAGLIAFERRI, Cecilia: "Education and systems thinking: from an information-centered to a human-centered education" - 1st Italian conf. on Systemics, Apogeo, Milano, 1998
- TAI-SUE, J. & FU-LONGE, T.: "A systems view of the evolution in information systems development"- SRBVS, 19(1) 2002

- TAINTER, Joseph A.: "The collapse of complex societies" - Cambridge Univ. Press, Cambridge, MA, 1988
- TAINTER, Joseph: "The Collapse of Complex Societies". Cambridge Univ. Press, 1988
- TAKAHASHI, J.S. & HOFFMAN, M.: "Molecular biological clocks". *Amer. Scientist*, 83 (2) 1995
- TAKENS, F. & RUELLE, D.: "On the nature of turbulence". *Comm. Math. Physics*, nr. 20 & 23, 1971
- TAKET, A. & WHITE, L.: "Pragmatic pluralism: an explication". *Syst. Pract.*, 9(6) 1996
- TAKET, A. & WHITE, L.: "Working with heterogeneity: a pluralist strategy of evaluation". *SRBVS*, 14(2) 1997
- TAKET, A. & WHITE, L.: "Experience in the practice of one tradition of multimethodology" - *SPAR*, 11(2) 1998
- TAKET, A. & WHITE, L.: "Partnership and Participation" - Wiley, Chichester, 2000
- TALBOT, Michael: "The holographic universe". Harper Perennial, New York, 1992
- TANSLEY, Arthur G.: "The Use and Abuse of Vegetational Concepts and Terms" - *Ecology*, Vol. 16, 1935
- TARNOW, Eugen: "Like Water and Vapor: Conformity and Independence in the Large Group". *Behav. Science* 41 (2), 1996
- TASCHDJIAN, E.: "Inductive resonance as a stabilizing factor in adaptive systems". NATO panel on Org. Research, Porto, 1973
- TASCHDJIAN, E.: "The cybernetics of stressed systems". *Cyb. & Syst. Research*, 2 (p.77-81) 1984
- TASCHDJIAN, E.: "The dimension of power". *Odobleja Newsletter*, nr.10, 1986
- TATTERSALL, Ian: "How we came to be human" - *Sc. Amer.*, Dec. 2001
- TAUBER, A.I. (ed.): "Organism and the origin of the self" - Kluwer, Dordrecht, 1991
- TAYLOR, Alastair M.: "Process and structure in social systems", in Jantsch, E. & Waddington, C. (eds): "Evolution and consciousness". Addison-Wesley, Reading, Mass., 1976
- TAYLOR, M.J. et al.: "Soft issues in small scale network development and implementation in SME" - *SPAR*, 14(3) 2001
- TAYLOR, M.J. & MOYNIHAN, E.: "Analysing information technology ethics" - *SRBVS*, 19(1) 2002
- TAYLOR, W.P.: "What is Ecology and what good it is?" - *Ecology*, Vol. 17 (1), 1936
- TEHRANIAN, M.: "Toward a systemic theory of national development" - IMI Press, Teheran, Iran
- TEILHARD DE CHARDIN, Pierre: "La Formation de la Noosphère" - *Revue des Questions Scientifiques* - Université de Louvain, Belgium, January 1947.
- TEILHARD de CHARDIN, Pierre: "L'Avenir de l'Homme" - Editions du Seuil, Paris, 1959
- TENIERE-BUCHOT, P.F.: "Sur l'analyse de système" - *Futuribles*, nro. 20, 1979, p. 42-57
- TENNER, E.: "Why things bite back" - A. Knopf, New York, 1996
- TEUBNER, Gunther (ed.): "Autopoietic law: a new approach to law and society" - W. de Gruyter, Berlin, New York, 1988
- TEUBNER, Gunther: "Law as an autopoietic system" - Blackwell Publ., London, 1993
- TEUNE, Henry: "Systems dynamics and systems transitions", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Public. Madrid, 1993
- THALER, D.S.: "The evolution of genetic intelligence" - *Science*, 264, 1994
- THAYER, Lee: "Communication and communication systems". Irwin, Homewood, IL., 1968
- THAYER, Lee: "Communication systems". in Laszlo, E.: "The relevance of General Systems Theory". Braziller, New York, 1972
- THAYER, Lee: "General Systems Theory: The promise that could not be kept". *Acad. of Management J.*, 1972
- THELEN, E. & SMITH, L.B.: "A dynamic systems approach to the development of cognition and action" - MIT Press, Cambridge, MA, 1994
- THEOBALD, Robert: "Global transformational learning communities" - *C&HK*, 3 (2), 1995
- THERAULAZ, G. & SPITZ, F.(coord.): "Auto-organisation et comportement" - Ed. Hermès, Paris, 1997
- THERAULAZ, G. et al.: "Les insectes architectes ont-ils leur nid dans la tête" - *La Recherche*, nro. 313, oct. 1998
- THIERIE, J.: "Partitions d'un système global cohérent en parties faiblement discernables". *Rev. Intern. de Systémique*, 4 (4) 1990
- THILL, G. & FELTZ, B.: "Auto-organisation et approche systémique des pratiques de recherche". Presses Univ. de Namur, Belgium, 1986
- THIOLLENT, M.: "Uses of knowledge: some methodological alternatives" in G. de Zeeuw (ed.) "Knowledge (dis) appearance". Systeem Groep Nederland, Delft Univ.Press, 1986
- THOM, René: "Modèles mathématiques de la morphogénèse". Plon, U.G.E., Paris, 1974
- THOM, René: "D'un modèle de la science à une science des modèles". *Synthese*, 31 (2) 1975
- THOM, René: "Stabilité structurelle et morphogénèse: essai d'une théorie générale des modèles". Ediscience, Paris, 1972 or, in English: W.A. Benjamin, Reading, Mass., 1977
- THOM, René: "Paraboles et catastrophes". Flammarion, Paris, 1983
- THOM, René: "Esquisse d'une Sémiophysique". Inter-éditions, Paris, 1988
- THOM, René: "Apologie du logos" - Hachette, Paris, 1990
- THOM, René: "Semio Physics; a sketch" - Addison-Wesley, Redwood City, CA, 1990
- THOM, René: "Prédire n'est pas expliquer". Flammarion, Paris, 1993
- THOMAS, Jim: "Gripping Chemistry" - *N.Sc.*, Nr.2163, December 5th, 1998
- THOMPSON, d'Arcy Wentworth: "On growth and form". Cambridge Univ. Press, London, 1952 (Original 1916)
- THOMPSON, J.N.: "Interaction and Coevolution" - Wiley, New York, 1982
- THOMPSON, J.B.: "Studies in the theory of ideology" - Univ. of California Press, Berkeley, 1984
- THOMPSON, KLEIN, Julie: "Interdisciplinarity: History, Theory and Practice". Wayne Univ. Press, Detroit, Michigan, 1990 (Contains 94 pages of references!)
- THORNDIKE, E.L.: "Animal Intelligence: Experimental Studies" - Hafner, New York, 1965 (First published, 1911)
- THORNDIKE, E.L.: "Human Learning" - Century, New York, 1931
- THORSHEIM, Howard & ROBERTS, Bruce: "Meta-perspectives: The systems approach and its wisdom". Intersystems, Seaside, CA, 1984
- THUROW, Lester: "The Zero-sum Society: Distribution and the Possibilities for Economic Change" - Basic Books, New York, 1980
- THYSSEN, Ole: "Ethics as 2nd. order morality" - *C&HK*, 1(1) 1992
- THYSSEN, Ole: "Second order morality and organizations" - *C&HK*, 3(2) 1995
- THYSSEN, Ole: "Some basic notions in the systems theory of N. Luhmann" - *C&HK*, 3 (2) 1995
- TIERCELIN, Claudine: "La pensée signe: Etudes sur Ch.S. Peirce" - J. Cambon, Nîmes, France, 1993
- TILLEY, David R.: "Emergy basis for ecosystems management: valuing the work of nature" - 42nd. conf. of ISSS, Georgia Technology Institute, Atlanta, 1998
- TINBERGEN, Niko: "La vie sociale des animaux". Payot, Paris, 1971
- TINBERGEN, N.: "The animal in its world" - Allen and Unwin, London, 1973
- TODA, M. & SHUFORD, E.Jr.: "Logic of systems: Introduction to a formal theory of structure". *SGSR Yearbook*, 10, 1965
- TODA, Masanao: "The decision process: a perspective". *Intern. J. Gen. Systems*, 3 (2) 1976
- TÖNNIES, Ferdinand: "Gemeinschaft und Gesellschaft". Buske, Darmstadt, 1935 (French translation used: "Communauté et Société". P.U.F., Paris 1944)
- TÖTÖSY de ZEPETNEK, Steven: "Comparative literature and systemic/institutional approaches to literature". *Syst. Research*, 11 (2) 1994
- TOFFOLI, R. & MARGULIS, N.: "Cellular automata machines". MIT Press, Cambridge, Mass., 1987
- TOLMAN, E.C.: "Purposive behavior in animals and man" - Appleton, New York, 1932
- TOMASELLO, M.: "The cultural origin of human cognition" - Harvard Univ. Press, 1999
- TOMLINSON, N.R. & KISS, I.: "Rethinking the process of operation research and systems analysis". Pergamon, Oxford, 1984
- TONG, Richard M.: "Synthesis of fuzzy models for industrial processes". *Intern. J. Gen. Systems*, 4 (3) 1978
- TONINI, Valerio: "Il Concetto di Struttura nelle Scienze moderne". Scientia, 2, Milano, 1954
- TONINI, Valerio: "Scienza della informazione, Cibernética e Epistemologia". Bulzoni, Roma, 1971
- TONNELAT, Jacques: "Thermodynamique et biologie". 2 Vol., Maloine, Paris, 1980
- TOPP, Warren: "Knowledge systems diagnostics: applying FOUCAULT's archeological framework to organizations" - *SRBVS*, 17 (4) 2000
- TORBERT, W.R.: "The power of balance: transforming self, society and scientific inquiry" - Sage, Newbury Park, CA, 1991
- TORLAK, Gökhan: "Rationalization of metaphorical exploration" - *SPAR*, 14(4) 2001
- TORLAK, Gökhan: "Reflections on multimethodology interventions" - *SPAR*, 14(3) 2001
- TOTH, Herbert: "On some metascientific aspects of fuzzy set theory". *Cyb. & Systems Research '92*, World Scientific, Singapore, 1992

- TOWNLEY, B.: "Reframing human resource management: power, ethics and the subject at work" - Sage, London, 1994
- TRACY, Lane: "Leading the living organization: growth strategies for management" - Greenwood, Westport, CT, 1994
- TRACY, Lane: "Negociation: an emergent process of living systems" - *Behav. Science*, 40, 1995
- TRACY, Lane: "Genes, Memes, Templates and Replicators". *Behav. Science*, 41 (3), 1996
- TRACY, Lane: "How to kill a living system" - Proc. 42nd ISSS Conf., Atlanta, 1998
- TRANOY, Knut Erik: "Wholes and structures". Munksgaard, Copenhagen, 1959
- TRAPPL, Robert (ed): "Cybernetics: a Sourcebook". Halsted, Washington D.C., 1978
- TRAPPL, Robert (ed): "Power, autonomy, utopia". Plenum Press, New York, 1986
- TRAPPL, R. & PETTA, P. (eds.): "Creating personalities for synthetic actors" - Springer, Heidelberg, New York, 1997
- TRAPPL, Robert: "Can we create an artificial mind in the 21st. century?" - Proc. Cyb. & Syst. 2000 Conference - Austr. Soc. Cyb. Studies, Vienna, 2000
- TRAPPL, R., HORN, W. & KLIR, G.J.: "Basic and applied general research: a bibliography 1977-1984". *Cyb. & Systems*, suppl. of vol. 16, 1985
- TRAUB, J.F. (ed): "Algorithms and complexity". Academic Press, New York, 1976
- TREVEN, S. & MULEJ, M.: "Combining technological and non-technological innovation: a frequently missing precondition for effective working of information systems offices" - Proc. 7th IDIMT, Zadov, Univ. Verlag R. Trauner, Linz, 1999
- TRIST, E. & MURRAY, H. (eds.): "The social engagement of social science: I. The socio-psychological perspective, II. The socio-technical perspective" - Univ. of Pennsylvania Press, Philadelphia, 1990/93
- TRIST, E. et al. (eds.): "The social engagement of social science, III. The socio-ecological perspective" - Univ. of Pennsylvania Press, Philadelphia, 1997
- TROLL, A. & FEITEN, W.: "Improving neural net training". *Cyb. & Systems*, 23 (3/4) 1992
- TRONCALE, L.R.: "Linkage propositions between principal system concepts" - Proc. 26th, Ann. Meet., SGSR, 1982, p. 27-38
- TRONCALE, L.R.: "Some key, unanswered questions about hierarchies" - Proc. 26th. Ann. Meet., SGSR, 1982, p. 77-81
- TRONCALE, L.R. & VOORHEES, B.H.: "Towards a formalization of system linkage propositions" - Proc. Ann. Conf. SGSR, 1983, p. 187-195
- TRONCALE, Len R.: "The future of General System Research". *Syst. Research*, 2 (1) 1985
- TRONCALE, Len R.: "Allometry in biology: Allometry in Systems Science generalized systems forms", in Proc. 30th ISSS Meeting, Philadelphia, 1986
- TRONCALE, L.R.: "Ecological sustainability through systems education" - Proc. 42nd ISSS Conf., Atlanta, 1998
- TSAGDIS, Dimitros: "Pointing towards some superior Metaphysics, Ontology and Epistemology" - SRBVS, 19 (2), 2002
- TSIVACOU, Ioanna: "Structure and agency in systems rationality", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- TSIVACOU, I.: "The rationality of distinctions and the emergence of poser" - SRBVS 14(1) 1997
- TSYPKIN, Y.Z.: "Adaptation and Learning in Automatic Systems" - Academic Press, New York, 1971
- TUDGE, Colin: "Last stand for society snails". *New Scientist*, nr. 1829, July 11, 1992
- TURCHIN, V.F.: "The phenomenon of science" - Columbia Univ. Press, New York, 1977
- TURCHIN, Valentin: "On cybernetic epistemology". *Syst. Research*, 10 (1) 1993
- TURCHIN, Valentin: "The cybernetic ontology of action". *Kybernetes*, 22 (2) 1993
- TURING, Alan M.: "Computing machines and intelligence". *Mind*, 59, 1950
- TURING, Alan M.: "A chemical basis for biological morphogenesis". *Phil. Trans. Royal. Soc.*, London, Sr.B, 237, 37, 1952
- TURING, Alan M.: "Can a machine think?", in Newman, James R. (ed): "The world of mathematics". Vol.4, pp.2099-2123, Simon & Schuster, New York, 1956
- TURNER, B.L. et al.: "The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years" - Cambridge Univ. Press, New York, 1990
- TURNER, Frederik: "Chaos and social science" in EVE, R. et al. (eds.): "Chaos, complexity and sociology" - Thousand Oaks, Sage, CA, 1997
- TURNER, Jack S.: "Self-organization in non equilibrium chemistry and in biology", in Schieve, W. & Allen, P. (eds): "Self organization and dissipative structures". Univ. of Texas Press, Austin, 1992
- TURNER, S.: "The social theory of practices: tradition, tacit knowledge and presuppositions" - Polity Press, Cambridge, 1994
- UEDA, Y. (Ed.): "The Road to Chaos" - Aerial Press, Santa Cruz, CA., 1992
- UEXKULL, Jacob von & KRISZAT, G.: "Streifzüge durch die Umwelten von Tieren und Menschen". J. Springer, Berlin, 1934
- UEXKULL, Jakob von: "Bedeutungslehre" - J.A. Barth, Leipzig, 1940
- UEXKULL, Jakob von: "The theory of meaning" - *Semiotica*, 42, 1982 (first publ. in German, 1940)
- UEXKULL, Jakob von: "Mondes animaux et mondes humains" - D. Gonthier, Paris, 1972
- UEXKULL, Jacob von: "Theoretische Biologie". Springer, Berlin, 1928, or Suhrkamp, Frankfurt am Main, 1979
- UEXKULL, Jakob von: "Umwelt und Innenwelt der Tiere" - Springer, Berlin, 1999
- UEXKULL, Jakob von: (see KULL, Kalevi, ed.) (on J. von Uexkull's concept of Umwelt)
- UEXKULL, Thure: "The sign theory of Jakob von Uexküll" - *Semiotica*, 89, 1992
- ULANOWICZ, R.E.: "Growth and development: ecosystems phenomenology" - Springer, New York, 1986
- ULANOWICZ, R.E.: "Ecology: the ascendent perspective" - Columbia Univ. Press, New York, 1997
- ULANOWICZ, R.E.: "A phenomenology of evolving networks" - SRBVS 15(5) 1998
- ULIGIATI, S.: "Emergy, environmental loading, and carrying capacity of production systems" - Proc. 42nd ISSS Conf., Atlanta, 1998
- ULLMANN, S.: "Semantics: an introduction to the science of meaning" - Basil Blackwell & Mott, Oxford, 1962
- ULRICH, Hans (ed.): "Management-Philosophie für die Zukunft" - Haupt, Bern, 1981
- ULRICH, H. & PROBST, G.: "Self-organization and management of social systems" - Springer, Berlin, 1984
- ULRICH, H. & PROBST, G.: "Anleitung zum ganzheitlichen Denken" - Haupt, Bern, 1987
- ULRICH, H. & PROBST, G.: "Anleitung zum ganzheitlichen Denken und Handel; ein Brevier für Führungskräfte." - Haupt, Bern, 1995
- ULRICH, Hans: "Systemorientiertes Management: das Werk von Hans Ulrich (Zusammenstellung: Markus SCHWANINGER)" - Haupt, Bern, 2001
- ULRICH, Werner: "A critique of pure cybernetic reason: the Chilean experience with cybernetics" - *J.Appl.Syst.Anal.*, 8(33)1981
- ULRICH, Werner: "Critical heuristics of social planning". Haupt, Bern, 1983
- ULRICH, Werner: "The Metaphysics of social design", in van Gigh, J. (ed): "Decision making about decision making". Abacus, Cambridge, Mass., 1987
- ULRICH, Werner: "Churchmann's "Process of unfolding": its significance for policy analysis and evaluation" - *Syst. Pract.*, 1, 1988
- ULRICH, Werner: "Systems Thinking, Systems Practice and Practical Philosophy: A Program of Research" - *Syst. Practice*, Vol.1, Nr.2, 1988
- ULRICH, Werner: "Critical heuristics of social planning: a new approach to practical philosophy" - J.Wiley, Chichester, 1994
- ULRICH, Werner: "A Primer to critical systems heuristics for action researchers" - Center for Systems Studies, Univ. of Hull, 1996
- ULRICH, Werner: "The quest for competence in Systemic Research and Practice" - SRBVS, 18(1) 2001
- ULTSCH, Alfred: "An artificial life approach to data mining" - Proc. 15th Cyb. & Syst. Meet., Austr. Soc. for Cyb. Stud., Vienna, 2000
- UMPLEBY, Stuart A.: "Heinz von Foerster, a 2nd. order cybernetician". *ASC Cyb. Forum*, IX, (3) 1979
- UMPLEBY, Stuart A.: "Linear and elitist: how our critics see us". *ASC Cyb. Forum*, IX (4) 1979
- UMPLEBY, Stuart A.: "Science of Cybernetics and Cybernetics of science". *Cyb. & Systems*, 21 (1) 1990
- UMPLEBY, Stuart A.: "Two kinds of general theories in systems sciences". *Cyb. and Systems '94*, World Scientific, Singapore, 1994
- UMPLEBY, Stuart A.: "Four models from Cybernetics to guide our understanding of Cyberspace". *Cyb. and Systems '96*, Austrian Soc. for Cyb. Studies, Vienna, 1996
- UMPLEBY, Stuart: "The cybernetics of conceptual systems" - *C&S*, 28(8), 1997
- UMPLEBY, Stuart: "What comes after 2nd. order cybernetics" - *C&HK*, 8(3) 2001
- UMPLEBY, Stuart: "Should knowledge of management be organized as theories or as methods" - Proc. 16th Meeting of Cyb. & Syst., Vienna, 2002
- UNESCO: "Enfoque Sistemico del Proceso Educativo" - Anaya, Madrid, 1979
- UNESCO-UNEP: "Glossary of environmental educational terms". Vespem, Hungary, 1983

- UNITED NATIONS UNIVERSITY: "The science and praxis of complexity". U.N.U. Press, 560, Tokyo, 1985
- UNIVERSITE DES NATIONS UNIES: "Science et pratique de la complexité: Actes du colloque de Montpellier" - La Documentation Française, Paris, 1986
- UYEMOV, Avenir I.: "Problems of direction of time and laws of systems development", in Kubal, L. & Zeman, J. (eds.): "Entropy and information". Elsevier, New York, 1975
- VACCARI, E & DELANEY, W.: "Systems theory as a frame of reference in natural languages processing". Syst. Research, 3 (3) 1986
- VACCARI, Erminia: "Knowledge and Modelling" - C&HK 5(2), 1998
- VACCARI, Erminia & DELANEY, Eugenia: "Cognitive Modelling in the Systems Theory Paradigm" - SRBVS, 16 (3) 1999
- VACCARI, E. & D'AMATO, M.: "The dynamic perspective to cognitive science" - CASYS J., 7, Liège, Belgium, 2000
- VACCARINO, G.: "La chimica della mente" - Carbone, Messina, 1977
- VACCARINO, G.: "Scienza e semantica costruttivista" - Metope/CLUB, Milano, 1988
- VAHL, Martha: "Managing stories: a community research perspective on water". Cyb. and Systems '96, Austrian Soc. for Cyb. Studies, Vienna, 1996
- VAHL, Martha: "How to sustain a community: stories and actorship" - Proceed. 14th Meeting of Cybernetics and Systems, Vienna, 1998
- VAHL, Martha: "A challenge to research: the improvement of communities" - Systemica, 12, 1999
- VAHL, Martha: "Gerard de Zeeuw: Models, Systems, support and research" - SRBVS, 19(2) 2002 (the whole issue is a Festschrift in honor of G. de Zeeuw)
- VAJDA, Igor: "From perceptron to the Boltzman machine: information processing by cognitive networks" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- VALEN, Leigh M.: "The other synthesis". Amer. Scientist, 83 (3) 1995
- VALLÉE, R. & SCHLEICHER, M. (eds): "Théorie des Systèmes et théorie des jeux". Economies et Sociétés, 6, 1980
- VALLÉE, Robert: "En hommage à Jean Ullmo". Economie Appliquée, (36) 2/3, 1983
- VALLÉE, Robert: "About Heinz von Foerster's Eigen-elements". Syst. Sciences, 10 (1) 1984
- VALLÉE, Robert: "Stephan Odobleja, précurseur de la Cybernétique". Odobleja Newsletter, nr.8, 1985
- VALLÉE, Robert: "Sur les 'éléments propres' de H. von Foerster" - Rev. Internat. Systémique, 1(1), 1987
- VALLÉE, Robert: "Autonomie et communication" - Analyse de Systèmes 15(1) 1989
- VALLE, R.S. & von ECKARTSBERG, R. (eds.): "Metaphors of consciousness" - Plenum Press, New York, 1989
- VALLÉE, Robert: "Sur quelques concepts de la théorie des systèmes", in "La systématique en tant que nouvelle forme de connaissance". Symp. écrit, nr.2, Inst. de la Méthode, Bienne, 1990a
- VALLÉE, Robert: "Plato's cave revisited". Kybernetes, 19 (3) 1990b
- VALLÉE, Robert: "Sur la complexité d'un système relativement à un observateur". Rev. Intern. de Systémique, 4 (2) 1990c
- VALLÉE, Robert: "Concerning some concepts of systems theory". Intern. Federation for Systems Research Newsletter, nr.29, 1991a
- VALLÉE, Robert: "La cognition et le paradoxe de l'observation-action", in Andreewsky, E. (ed): Systémique et Cognition. Dunod, Paris, 1991b
- VALLÉE, Robert: "Systèmes Cybernétiques et Epistémologie - praxéologie". Epistémé, (2) 1991c (Dakar, Sénégal)
- VALLÉE, Robert: "Perception, memorization and multi-dimensional time". Kybernetes, 20 (6) 1991d
- VALLÉE, Robert: "Systèmes dynamiques linéaires", in Le Gallou, F. & Bouchon-Meunier, B. (eds.): "Systémique: théorie et application". Lavoisier, Paris, 1992b
- VALLÉE, Robert: "Auto-organisation, auto-référence et autonomie", in Le Gallou, F. & Bouchon-Meunier, B. (eds.): "Systémique: théorie et application". Lavoisier, Paris, 1992c
- VALLÉE, Robert: "Fixed" points and interacting subjects". Kybernetes, 21 (4) 1992d
- VALLÉE, Robert: "Systems theory, a historical presentation", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Syst. Science Handbook". Systemic Public., Madrid, 1993
- VALLÉE, Robert: "About mappings". Kybernetes, (22) 6, 1993b
- VALLÉE, Robert: "About intrinsic time of a dynamical system". Proc. 12th Eur. Meet. Cyb. and Syst., Vienna, 1994
- VALLÉE, Robert: "Origine et évolution de la théorie des systèmes" - 3ra. Escuela Europea de Sistemas, Universidad de Valencia, España, 1994
- VALLÉE, Robert: "Cognition et Système: Essai d'Epistémologie-praxéologie". L'Interdisciplinaire, Lyon, 1995
- VALLÉE, Robert: "La cybernétique et l'avenir de l'homme". Impact, Science et Société, 3 (3) 1952 (Reprinted in Rev. Intern. de Systémique. 9 (4) 1995)
- VALLÉE, Robert: "Observation, memorization and causal operators". Cyb. and Systems '96, Austrian Soc. for Cyb. Studies, Vienna, 1996
- VALLÉE, Robert: "Théorisation de la perception-action et autonomie de Vendryes" - Rev. Internat. Systémique 11(5) 1997
- VALLÉE, Robert: "An introduction to 'epistemo-praxiology'". C&HK, 5(1) 1998
- VALLÉE, Robert: "The many roots of cybernetics" - Proc. 16th Meeting of Cybernetics and Systems, Vienna, 2002
- VALLÉE, Robert: "Mathematical and formalized epistemologies" - in Mugur-Schächter, M. & Vander Merwe, Alwyn (eds.): Quantum mechanics, mathematics, cognition and action. - Kluwer, Dordrecht, Boston, 2002
- VALLET, Claude et MOULIN, Thibaut: "Le relateur arithmétique: Un outil bien adapté à la systématique", Proc. European Congress of Systems Science, Lausanne, 1989
- VAMOS, T. et al.: "Lessons of the pattern view of knowledge". Cybernetics & Systems Research '92, World Scientific, Singapore, 1992
- VANCOUVER, Jeffrey B.: Living Systems Theory as a Paradigm for Organizational Behavior". Behav. Science, 41 (3), 1996
- VANDERSTRAETEN, Raf: "The autopoiesis of educational organizations" - SRBVS, 19(3) 2002
- VANDERVERT, Larry R.: "Systems thinking and a proposal for a neurological positivism". Syst. Research, 5 (4), 1988
- VANDERVERT, Larry (ed.): "Understanding tomorrow's mind: advances in chaos theory, quantum theory and consciousness in psychology" - Special issue J. Mind & Behav., 18(2/3) 1997
- VARDOMATSKY, Andrei P.: "Morality as a regulatory system", in Banathy, B. & Rodriguez Delgado, R. (eds): "Intern. Systems Science Handbook". Systemic Public., Madrid, 1993
- VARELA, Francisco: "A calculus for self-reference". Intern. J. Gen. Systems, 2 (1) 1975
- VARELA, Francisco & GOGUEN, J.A.: "The arithmetic of closure" J. of Cyb. V.8 (3/4) 1979
- VARELA, Francisco: "The extended calculus of indications interpreted as a 3-valued logic". Notre-Dame J. of Formal Logic, 1979
- VARELA, Francisco: "Principles of biological autonomy". North Holland, New York, 1979
- VARELA, Francisco: "Describing the logic of the living" - in Zeleny (1981)
- VARELA, Francisco: "Two principles of self-organization", in Ulrich, H & Probst, G. (eds): "Self organization and management of social systems". Springer Verlag, Heidelberg, 1984
- VARELA, Francisco: "Autonomy and cognition". Elsevier, New York, 1980 (in French: "Autonomie et connaissance". Le Seuil, Paris, 1989)
- VARELA, Francisco: "Kognitionswissenschaft- Kognition Technik" - Suhrkamp, Frankfurt/am Main, 1990
- VARELA, Francisco et al.: "Autopoiesis: the organization of living systems: its characteristics and a model". Biosystems, 5, 1974 (also in G. Klir (ed): "Facets of systems science". Plenum Press, New York, 1991)
- VARELA, F. & DUPUY, J. (eds): "Understanding origins" - Kluwer, Dordrecht, 1992
- VARELA, Francisco & BOURGINE, Paul (Eds): "Toward a practice of autonomous systems" - M.I.T Press, Cambridge, Mass, 1992
- VARELA, Francisco et al.: "L'inscription corporelle de l'esprit". Le Seuil, Paris, 1993
- VARELA, Francisco: "A cognitive view of the immune system" - World Futures, 42, p. 31-40, 1994
- VARELA, Francisco: "The early days of autopoiesis: Heinz and Chile" - Syst. Research 13(3) 1996
- VARELA, Francisco (ed.): "Sleeping, dreaming and dying: an exploration of consciousness with the Dalai Lama" - Wisdom Publ., Boston, 1997
- VARELA, F., THOMPSON, E. & ROSCH, E.: "The embodied mind: cognitive science and human experience" - MIT Press, Cambridge, Mass., 1999
- VARELA, Francisco: "Ethical know-how: action, wisdom and cognition" - Stanford Univ. Press, Stanford, CA, 1999
- VARELA, Francisco: "Present- time consciousness" - J. of Consciousness, 6 (1/2), 1999
- VARELA, F. & SHEAR, J.: "The view from within: first person approaches to the study of consciousness" - Imprint Academic, Thorverton, UK, 1999
- VARELA, F. et al.: "The brain web: phase synchronization and large-scale integration". Nature Rev. Neuroscience, 2, 2001

- VARELA, Francisco: "(A memorial issue about his life and work)" - C&HK, 9(2) 2002
- VASKO, T. (ed): "The long wave debate". Springer, Berlin, 1987
- VELKOV, D.L.: "Self-organization and cybernetics", in Dalenoort, G.J. (ed): "The paradigm of self-organization". Gordon & Breach, London, 1989
- VENDRYES, Pierre: "Vie et Probabilité". Albin Michel, Paris, 1942
- VENDRYES, Pierre: "Déterminisme et Autonomie". A. Colin, Paris, 1956
- VENDRYES, Pierre: "Vers la théorie de l'homme". Presses Univ. de France, Paris, 1973
- VENDRYES, Pierre: "L'autonomie du vivant". Maloine-Doin, Paris, 1981
- VENDRYES, Pierre: "Truth in the science of man". Syst. Research, 6 (2) 1989
- VENDRYES, Pierre: "Son oeuvre" Nro. Spécial de la Rev. Internat. Systémique, 11(5) 1997
- VERDAN, André: "Karl Popper, ou la connaissance sans certitude" - Presses Polytechniques et Univ. Romandes, Lausanne, 1991
- VERDEN-ZOLLER, Gerda: "Liebe und Spiel, die vergessene Grundlagen des Menschseins". AUER Verlag, 1993
- VERJUS, Jean Pierre: "Les systèmes informatiques répartis". La Recherche, nr. 204, nov. 1988
- VERLOREN van THEMAAT, W.A.: "Is science accumulative?" in G. de Zeeuw (ed) "Knowledge (dis)appearance" Systeem Groep Nederland, Delft Univ. Press, 1986
- VERMEIJ, G.J.: "Evolution and Escalation: An Ecological History of Life" - Princeton Univ. Press, 1987
- VERNADSKY, Wladimir: "La biosphère" - Alcan, Paris, 1929 (New ed. Diderot, Paris, 1997 (original in Russian in 1926))
- VESTER, Frederic: "Ballungsgebiete in der Krise". DTV Sachbücher, München, 1983
- VESTER, Frederic: "Denken, Lernen, Vergessen". DTV, München, 1983
- VESTER, Frederic: "Unsere Welt - ein vernetztes System". DTV, München, 1983
- VICHNIAC, Gérard: "Simulating Physics with Cellular Automata" - Physica D, 10:96, 1984
- VICKERS, Geoffrey: "Control, stability and choice". SGSR Yearbook, 2, 1957
- VICKERS, Geoffrey: "The regulation of political systems". SGSR Yearbook, 12, 1967
- VICKERS, Geoffrey: "Value systems and social process". Basic Books, New York, 1968, or Penguin Books, Harmondsworth, 1970
- VICKERS, Geoffrey: "Freedom in a rocking boat". Basic Books, New York, 1971
- VICKERS, Geoffrey: "Making institutions work". Assoc. Business Programmes, London, 1973
- VICKERS, Geoffrey: "The Future of Morality" - Futures, vol.11, Nr.5, October 1979
- VICKERS, Geoffrey: "Education in systems thinking". J. of Appl. Syst. Analysis, 7, 1980
- VICKERS, Geoffrey: "Responsability. Its sources and limits" - Intersystems Publ. - Seaside, CA, 1980
- VICKERS, Geoffrey: "Some implications of systems thinking" - In Open University Systems Group (ed): Systems Behavior - Harper & Row, London, 1981
- VICKERS, Geoffrey: "Social ethics" - In O.W. Markley & W. Harmon: Changing images of man- Pergamon Press, London, 1982
- VICKERS, Geoffrey: "Human systems are different" - Harper & Row, London, 1983a
- VICKERS, Geoffrey: "The art of judgment; a study of policy making" - Harper & Row, London, 1983b
- VIDYASAGAR, M.: "Nonlinear systems analysis" - Prentice Hall, N.J., 1993
- VIGOTSKY, L. S.: "Pensée et Langage" - Messidor, Editions Sociales, Paris, 1985 (Russian original, 1934)
- VIGOTSKY, L.S.: "Thought and language" - MIT Press, Cambridge, Mass., 1962 (russ. orig. 1934)
- VIGOTSKY, L. S.: "Mind in Society" - Harvard Univ. Press, Cambridge, Mass., 1978
- VIGOTSKY, L.S.: "Problems of theory and history of psychology" - In: Luria, R. & Yaroshevsky, M. (eds.): Problems of theory and history of psychology - Pedagogika, Moscow, 1982
- VIJVER, Gertrudis van de: "Who is galloping at a narrow path? Conversation with Heinz von Foerster" - C&HK, 4(1)1997
- VIJVER, Gertrudis (ed): "New perspectives on cybernetics: self-organization, autonomy and connectionism". Kluwer, Dordrecht, 1992
- VIJVER, Gertrudis van de: "Signs and systems (a review of J. HOFFMEYER's book)" C&HK, 4(4) 1997
- VIJVER, Gertrudis van de et al.(eds.): "Evolutionary systems: biological and epistemological perspectives on selection and self-organization" - Kluwer Academic, Dordrecht, 1998
- VILLASANTE, T. & GARRIDO GARCIA, F.: "Methodologies for the participant construction of knowledge" - SPAR, 14(4)2001
- VINES, Gail: "The Hand in your Head: The Cerebellum, our virtual Reality Center" - N.Sc., nr. 2185, May, 8th., 1999
- VIVIEN, Frank D.: "Quel prix accorder à la biodiversité?" - La Recherche Nr.333, Juillet-Août 2000
- VOGEL, Joseph H.: "Evolution as an entropy driven process: an economic model". Syst. Research, 5 (4) 1988
- VOGL, B. & JAROS, G.G.: "Celebration of diversity" - Educational Forum, 62, 1998
- VOLBERDA, H. & DE LEEUW, T.: "On the concept of organizational flexibility". Cyb. & Systems Research '92, World Scientific, Singapore, 1992
- VOLLMER, G.: "Evolutionäre Erkenntnistheorie". Hirzel, Stuttgart, 1983
- VOLTERRA, Vito: "Leçons sur la théorie mathématique de la lutte pour la vie". Gauthier Villars, Paris, 1931
- VOLTES BOU, Pedro: "La Teoría General de Sistemas". Hispano Europeo, Barcelona, 1978
- VOLTES BOU, Pedro: "Historical analysis and general systems theory". Proc. 36th. Meet. ISSS, Denver, 1992
- VOORHEES, Burton: "Correlational analysis of complex systems" - C&HK, 6 (3), 1999
- VULLIERME, Jean Louis: "Théories spéculaires et complexité". Rev. Intern. de Systémique, 4 (2) 1990
- WAAL, Frans de: "Good natured: the origins of right and wrong in humans and other animals" - Harvard Univ. Press, Cambridge, Mass., 1996
- WAAL, Frans de: "Les chimpanzés et nous" - La Recherche, 341, avr. 2001
- WADDINGTON, Conrad H.: "The Baldwin effect: genetic assimilation and homeostasis" - Evolution, 7, 1953
- WADDINGTON, Conrad: "The strategy of genes". Allen & Unwin, London, 1957
- WADDINGTON, Conrad: "The ethical animal". Allen & Unwin, London, 1960
- WADDINGTON, Conrad: "Principles of development and differentiation". MacMillan, New York, 1966
- WADDINGTON, Conrad H.: "Toward a theoretical biology" - Edinburgh, University Press, 1970
- WADDINGTON, Conrad: "The evolution of an evolutionist". Cornell Univ. Press, Ithaca, N.Y., 1975
- WADDINGTON, Conrad: "Concluding remarks" in Jantsch, E. & Waddington, C. (eds): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1976
- WADDINGTON, Conrad: "Stabilization in systems: Chreods and epigenetic landscapes". Futures, 9 (2) 1977
- WAELECHI, Fred: "Eleven theses of General Systems Theory" - Systems Research, 9 (4), 1992
- WAGENSBERG, Jorge: "Ideas sobre la Complejidad del Mundo" - Tusquets, Barcelona, 1994
- WAGENSBERG, Jorge: "L'âme de la méduse. Idées sur la complexité du monde" - Le Seuil, Paris, 1997. (Original in Spanish)
- WAGNER, Gerd: "Agent-object-relationship modeling" - Proc. 15th Cyb. & Syst. Meet., Austrian Soc. for Cybern. Studies, Vienna, 2000
- WAKS, S.: "Practical systems thinking" - Thomson Business Press, Boston, 1995
- WALBRIDGE, Charles T.: "Genetic algorithms: what computers can learn from Darwin" - Technology Review, 92(1), Jan. 1989
- WALD, G.: "The Cosmology of Life and Mind" - in HARMAN, W. & CLARK, J. (Eds): "New Metaphysical Foundations of Modern Science" - Inst. of Noetic Sciences, p. 123-31, 1994
- WALDAUER, F.D.: "Feedback". Wiley, New York, 1982
- WALDENFELS, B.: "Der Spielraum des Verhaltens (the latitude of behavior)" - Suhrkamp, Frankfurt/am Main, 1980
- WALDENFELS, B.: "Ordnung in Zwielicht (Order in the twilight)" - Suhrkamp, Frankfurt/am Main, 1987
- WALDROP, Mitchell, M.: "Complexity: The emerging Science at the Edge of Order and Chaos". Touchstone, Simon & Schuster, New York, 1993
- WALKER, Matt: "She's got have it" - N.Sc., Nr.2223, 29 Jan. 2000
- WALLENER, F. & KRATKY, K.W.: "Grundprinzipien der Selbstorganisation" - Wissenschaftliche Buchgesellschaft, Darmstadt, 1990
- WALLERSTEIN, Immanuel: "The modern world system" - Academic Press, New York, 1974
- WALLICH, Paul: "Silicon babies". Sc. American, 265 (6) 1991
- WALLISER, Bernard: "Systèmes et modèles". Le Seuil, Paris, 1977
- WALLISER, Bernard: "Une typologie des hiérarchies". Rev. Intern. de Systémique, 5 (1) 1991
- WALTER, Charles: "The global asymptotic stability of prey - predator systems with second order dissipation". Bull. Math. Biol., 36, 1974
- WALTER, W. Grey: "The living brain". Norton, New York; Duckworth, London, 1953

- WALTER, W. Grey: "An imitation of life", in "Automatic Control". A Sc. American Book. Simon and Schuster, New York, 1955
- WARD, Mark: "There is an ant in my phone" - N.Sc., Nr.2118, 24 Jan. 1998
- WARFIELD, John N.: "An assault on complexity". Battelle Mem. Institute, Columbus, OH. 1973
- WARFIELD, John N.: "Structuring complex systems". Battelle Mem. Institute, Columbus, OH. 1973
- WARFIELD, John N.: "Societal systems: Planning, policy and complexity". Wiley, New York, 1976
- WARFIELD, John: "The mathematics of structures" - Ajar Publishing co., 2003 (first ed. 1976 as part of "Societal Systems")
- WARFIELD, John & CHRISTAKIS, A.N.: "Dimensionality". Syst. Research, 4 (2) 1987
- WARFIELD, John N.: "Thinking about systems". Syst. Research, 24 (4) 1987
- WARFIELD, John N.: "Implicit aspects of much systems thinking". Syst. Research, 5 (4) 1988
- WARFIELD, John N.: "The magical number three - Plus or minus zero". Cyb. & Systems, 19, 1988
- WARFIELD, John N. & AKIYU, M.: "Sociotechnical modelling for development nations". SCIMA, New Delhi, 18 (1/2), 1989
- WARFIELD, John N.: "Underconceptualization". Systemica, Amsterdam, 1 (6/8) 1989a
- WARFIELD, John N.: "Economics and Systems Science". SCIMA, New Delhi, 19 (3) 1989b
- WARFIELD, John N.: "Societal Systems". Intersystems, Salinas, CA., 1989c
- WARFIELD, John N.: "Cybernetics, Systems Science, and the Great University". Syst. Research, 7 (4) 1990b
- WARFIELD, John N.: "Generic Planning". Knowledge in Society, 3 (4) 1990c
- WARFIELD, John N.: "Complexity and cognitive equilibrium: experimental results and their implications". Human Syst. Manag., 10, 1991
- WARFIELD, John N.: "Groupthink, clanthink, spread-think and linkthink". George Mason Univ., Fairfax, VA, 1993
- WARFIELD, John N. & CARDENAS, Roxana: "A Handbook of Interactive Management". 2 ed. Iowa State Univ. Press, Ames, Iowa, 1994
- WARFIELD, John N.: "Cybernetics". Encycl. Human Behavior, Vol. 2, Academic Press, New York, 1994a
- WARFIELD, John N.: "A science of generic design: managing complexity through systems design". Iowa State Univ. Press, Ames, Iowa, 1994b
- WARFIELD, John N.: "Complexity and Drummers". IA-SIS, Fairfax, VA., 1995a
- WARFIELD, John N.: "Mentomology: the identification and classification of mindbugs". J. Warfield, Fairfax, VA., 1995b
- WARFIELD, John N.: "Publications on Complexity". J. Warfield, Fairfax, VA., 1995c
- WARFIELD, John N.: "The Great University". J. Warfield, Fairfax, VA., 1995d
- WARFIELD, John N.: "Four books on complexity". J. Warfield, Fairfax, VA., 1995e
- WARFIELD, John N.: "A philosophy of Design". J. Warfield, Fairfax, VA, 1995f
- WARFIELD, John N. & STALEY, Scott M.: "Structural thinking: Organizing complexity through disciplined activity". Syst. Research, 13 (1) 1996
- WARFIELD, John N. & PERINO, George H. (Jr): "The Problematique: Evolution of an Idea" - SRBVS, Vol.16 (3), 1999
- WARFIELD, John N.: "Twenty Laws of Complexity Science Applicable in Organizations" - SRBVS, Vol.16, Nr.1, 1999
- WARFIELD, John: "A critical review of G. Soros book: the crisis of global capitalism" - SRBVS, 18(6) 2001
- WARUSFEL, André: "Les mathématiques modernes". Le Seuil, Paris, 1969
- WASSINK, E.C.: "Some remarks on amplifying mechanisms in living organisms". Annals of Syst. Research 1, Systeem Groep Nederland, 1971
- WATERS, Christina: "Invitation to dance: a conversation with H. von Foerster" - C&HK, 6 (4), 1999
- WATERS, Sam et al.: "Information: its dimension and quality" - 42nd. Conference of ISSS, Georgia Technology Institute, Atlanta, 1998
- WATSON, A.J. & LOVELOCK, J.: "Biological homeostasis of the global environment: the parable of Daisy world". Tellus 35B, 1983
- WATSON, J.D.: "The double helix" - W.W. Norton & Co, New York, 1980
- WATT, Kenneth F.E. & CRAIG, Paul P.: "Systems stability principles". Syst. Research, 3 (4) 1986
- WATT, Kenneth F.E.: "Taming the future: a revolutionary breakthrough in scientific forecasting". The Contextured Web Press, Davis, CA., 1992
- WATTS, Duncan: "Small worlds: The dynamics of networks between order and randomness" - Princeton Univ. Press, 1999
- WATTS, Duncan: "Six degrees" - W.W. Norton, New York, 2002 (On degrees of separation in "small worlds")
- WATTS, Geoff: "Make peace, not war" - N.Sc. 2376, Jan. 4, 2003 (On quorum sensing)
- WATZLAWICK et al.: "Pragmatics of Human Communication. A Study of Interactional Patterns, Pathologies, and Paradoxes" - W.W. Norton, New York, 1967
- WATZLAWICK, Paul & al.: "L'invention de la réalité". Le Seuil, Paris, 1988
- WATZLAWICZ, Paul: "Einführung in den Konstruktivismus". Piper, München, 1992
- WEAVER, Warren: "Science and complexity". Amer. Scientist, 36 (p.536-44), 1948
- WEAVER, Warren: "Lady Luck: The theory of probability". Penguin, Harmondsworth, 1963
- WEBER, Andreas: "The 'surplus of meaning': bio-semiotic aspects in F. VARELA's philosophy of cognition" - C&HK, 9 (2) 2002
- WEBER, B. & DEACON, T.: "Thermodynamic cycles; developmental systems and emergence" - C&HK, 7(1) 2000
- WEBER, S.: "Die Dualisierung des Erkennens: Zu Konstruktivism, Neuropsychologie und Medientheorie". Passagen Verlag, Vienna, 1996
- WEBSTER, G. & GOODWIN, B.: "Form and transformation: generative and relational principles in biology" - Cambridge Univ. Press, Cambridge, 1996
- WEBSTER, R.G. & WALKER, E.J.: "Influenza" (On pandemic propagation) - Amer. Sc. 91(2) March-Apr. 2003
- WEEKES, W.H.: "A general systems approach to management information systems". Odoheja Newsletter, nr.10, 1986
- WEEKES, W.H.: "Problems of disappearing knowledge in the teaching management" in G. de Zeeuw (ed.) Knowledge (dis)appearance. Systeem Groep Nederland, Delft Univ. Press, 1986
- WEEKES, W.H.: "Systemic approach to integrated management accounting". Proc. 35th Meet. ISSS, Östersund, Sweden, 1993
- WEEKES, William H.: "The de-mechanization of economics" - SRBVS 15(5) 1998
- WEENGART, P. et al (eds.): "Human by nature: between biology and the social science" - Erlbaum, Mahwah, NJ., 1996
- WEICK, K.E.: "Sensemaking in organizations" - Sage Publ., Thousand Oaks, CA, 1995
- WEIDLICH, W.: "Stability and cyclicity in social systems" - Behav. Science, 33, 1988
- WEIL, Susan: "Recreating Universities for 'Beyond the Stable State'" - SRBVS, Vol.16, Nr.2, 1999
- WEINBERG, Gerald M.: "An introduction to general systems theory". Wiley, New York, 1975
- WEINBERG, Gerald M.: "Problem solving methods in artificial intelligence" by Nils J. Nilsson (a review). Intern. J. Gen. Systems, 1 (1) 1975
- WEINBERG, Gerald M.: "Review of H.H. Pattee's book 'Hierarchy theory: the challenge of complex systems'". Intern. J. Gen. Systems, 1 (4) 1976
- WEINBERG, Gerald & Daniela: "On the design of stable systems" Wiley, New York, 1979
- WEINS, J.: "On competition and variable environments". Amer. Scientist, 65, 1977
- WEINSTEIN, K.: "Action learning" - Harper Collins, London, 1995
- WEIR, Michael: "Goal-directed behavior". Gordon and Breach, New York, 1984
- WEISBORD, M.: "Productive workplaces: organizing and managing for dignity, meaning, and community" - Berrett-Koehler, San Francisco, 1992
- WEISS, Gerhard (ed.): "Multiagent systems; a modern approach to distributed artificial intelligence" - MIT Press, Cambridge, MA, 1999
- WEISS, Paul A.: "The living system: determinism stratified", in Koestler, A. & Smythies, J.R. (eds): "Beyond Reductionism". Hutchinson, London, 1969
- WEISS, Paul A. (ed): "Hierarchically organized systems in theory and practice". Hafner, New York, 1971
- WEISSBERG, Berthold: "Les Champs morphogénétiques". Rev. de Biomathématique, 23, Paris, 1968
- WEISSMAN, D.: "Hypothesis and the spiral of reflexion" - State Univ. of New York Press, Albany, 1989
- WEIZENBAUM, Joseph: "Computer power and human reason". Freeman, San Francisco, 1976
- WENG, Ghezi, BHALLA, Upinder S. & IYENGAR, Ravi: "Complexity in Biological Signaling Systems" - Science, Vol.284, Nr.5411, p. 92-95, April 2nd, 1999
- WERNER, B.T.: "Complexity in Natural Landform Patterns" - Science, Vol. 284, April 2, 1999, p. 102-4
- WERNER, E. & DEMAIZEAU, Y. (eds.): "Decentralized A.I." (V.3) - Elsevier, Amsterdam, 1992
- WERTHEIMER, M.: "Productive thinking" - Tavistock, London, 1949
- WERTHEIMER, M.: "Principles of perceptual organization" - in BEADSLER D. & WERTHEIMER, M.(eds.) : "Readings in perception" - Van Nostrand, New York, 1958

- WERTHEIMER, Max: "Untersuchungen zur Lehre von der Gestalt". Psychol. Forschung nr.1, 1922 & nr.4, 1923. Springer, Berlin
- WERTSCH, J.V.: "Culture, communication and cognition"- Cambridge Univ. Press, London, 1985 a
- WERTSCH, J.V.: "Vygotsky and the social formation of the mind"- Harvard Univ. Press, Cambridge, MA, 1985 b
- WESSEL, K.F. (ed.): "Humanontogenische Forschung: der Mensch als Biophychozoiale Einheit" - Deutsche Verlag der Wissenschaften, Berlin, 1991
- WESSON, R.: "Beyond natural selection" - The MIT Press, Cambridge, 1994
- WEST, D. & STANSFIELD, M.: "Structuring action and reflection in IS action research studies"- SPAR 14(3) 2001
- WEST B.J. & GOLDBERGER, A.M.: "Physiology in fractal dimensions" - Amer. Scientist, V.75 (4), 1987
- WEYL, Hermann: "Raum, Zeit, Materie". Springer, Berlin, 1925. Reprinted as "Space, Time and Matter" as translated from the 4th German ed., Dover, New York, 1952
- WHEELER, W.M.: "Emergent Evolution of the Social" - in BRIGHTMAN, E.S. (Ed): Proceedings of the 6th. International Congress of Philosophy - Longmans, Green and Co, New York, 1927
- WHITE, Douglas: "Network analysis and social dynamics"- Proc. 16th Meet. on Cybernetics and Systems, Vienna, 2002
- WHITE, Harrison C.: "Identity and control: a structural theory of action" - Princeton Univ. Press, Princeton, NJ., 1992
- WHITE, John: "Language and the human condition". Fields within fields, nr.12, 1974
- WHITE, Jay D.: "A review of J. Sutherland's book: 'Systems: analysis, administration and architecture'". Intern. J. Gen. Systems, 4 (1) 1977
- WHITE, Leslie A.: "The evolution of culture". McGraw Hill, New York, 1959
- WHITE, Leroy: "Effective governance" through complexity thinking and management science"- SRBVS, 18(3) 2001
- WHITE, Leroy: "The role of systems research and operational research in community development"- SRBVS, 20 (2) 2003
- WHITEHEAD, Alfred N.: "Modes of thought" - The Free Press, New York, 1938 (Reprint : Macmillan, New York, 1966)
- WHITEHEAD, Alfred N.: "Process and Reality" - The Free Press, New York, 1979
- WHITESIDES, George M.: "Self-assembling materials". Sc. American, 273 (3) 1995
- WHITESIDES, George M. & ISMAGILOV, Rustem F.: "Complexity in Chemistry" - Science, Vol.284, Nr. 5411, p.89-92, April 2nd, 1999
- WHITTAKER, R. M.: "Communities and ecosystems". Mac Millan, New York, 1970
- WHORF, Benjamin L.: "Language, thought and reality". Wiley, New York, 1956
- WHORF, Benjamin L.: "The relation of habitual thought and behavior to language", in Adams, P. (ed.): "Language in thinking". Penguin, Harmondsworth, 1972
- WHYTE, L.L., WILSON A. & D.L.(eds): "Hierarchical structures" Academic Press, New York, 1969
- WHYTE, L.L.: "Accent on form" (1951). Reprint: Greenwood Press, Mass., 1973
- WHYTE, W.F.(ed.): "Participatory action research" - Sage, Newbury Port, CA, 1991
- WICKEN, Jeffrey S.: "The generation of complexity in evolution: a thermodynamic and information-theoretical discussion". J. Theor. Biol., 87, 1979
- WICKEN, Jeffrey S.: "Evolution, thermodynamics and information: Extending the Darwinian program". Oxford Univ. Press, New York, 1987
- WICKEN, Jeffrey S.: "Evolution and thermodynamics: the new paradigm". Syst. Research, 6 (3) 1989
- WICKEN, Jeffrey S.: "Quantifying biological information". Syst. Research, 6 (2) 1989
- WIENER, Norbert: "Cybernetics: control and communication in the animal and the machine". Hermann, Paris, 1948
- WIENER, Norbert: "The human use of human beings: Cybernetics and Society". Anchor, Doubleday, New York, 1954
- WIENER, Norbert: "Time and organization". 2nd Fawley Found. Lecture, Univ. Southampton, 1955
- WIENER, N. & SCHADE, J.P. (eds): "Nerve, Brain and Memory Models". Elsevier, Amsterdam, 1963
- WIENER, Norbert: "Cybernetics: control and communication in the animal and the machine". Hermann, Paris, 1948 2 ed. revised with two additional chapters. - MIT Press, New York, 1965
- WIENER, N. & SCHADE, J.P. (eds): "Progress in Cybernetics: Vol. 1, Elsevier, Amsterdam, 1964; Vol. 2, 1965; Vol.3, 1966
- WIESER, Wolfgang: "Organismen, Strukturen, Maschinen". Fischer, Frankfurt, 1959
- WIESER, Wolfgang: "Die Erfindung der Individualität" - Spektrum Akad. Verlag, Heidelberg, 1998
- WIGGINS, Stephen: "Global bifurcations and chaos". Springer Verlag, New York, 1988
- WIGNER, Eugene P.: "Symmetries and reflections" - Univ. of Indiana Press, Bloomington, 1967
- WILBER, Ken (ed): "The holographic paradigm and other paradoxes". Shambhala Public., Boston, 1982
- WILBER, K.(ed.): "Le paradigme holographique" - Le Jour Editeur, Montreal, 1984
- WILBY, Jennifer: "Developing total system intervention: the critical review mode"- Syst. Practice, 9(3) 1996
- WILBY, Jennifer (Ed.): "Forum One: Action Research and Critical Thinking" - Centre for Systems Studies, Univ. of Hull, England, 1996 a
- WILBY, Jennifer (Ed.): "Systems Methodology Forum II: Possibilities for Cross-cultural Learning and Integration" - Centre for Systems Studies, Univ. of Hull, England, 1996 b
- WILBY, J. & GREGORY, Wendy(eds.): "Forum three: Consciousness and decision making" - Univ. of Hull, 1997
- WILBY, J. & ZHU, Z.: "Systems Methodology III: Possibilities for Cross-cultural Learning and Integration" - Centre for Systems Studies, Univ. of Hull, England, 1997
- WILBY, Jennifer: "Three paths for exploring hierarchy theory" - 42nd conference of ISSS, Georgia Technology Institute, Atlanta, 1998
- WILDEN, Anthony: "L'écriture et le bruit dans la morphogénèse du système ouvert". Communications n° 18. Le Seuil, Paris, 1972
- WILDEN, Anthony: "System and structure". Tavistock, London, 1980
- WILDGEN, W.: "Archentypen-semantic" - Gunter Narr Verlag, Tübingen, 1985
- WILEY, N.: "The semiotic self" - Polity Press, Cambridge, MA, 1994
- WILLIAMS, R. & MARTINEZ, N.: "Simple rules yield complex foodwebs" - Nature, 404, p. 180, 2000
- WILLKE, Helmut: "Systemtheorie"
I. Grundlagen: Eine Einführung in die Grundprobleme sozialer Systeme.
II. Interventionstheorie: Grundzüge einer Theorie der Intervention in komplexe Systeme
III. Steuerungstheorie: Grundzüge einer Theorie der Steuerung komplexer Sozialsysteme - Lucius & Lucius, Stuttgart, 1982 - 1998
- WILLS, Christopher: "Safety in Diversity" - N.Sc., Nr.2022, 23 March 1996
- WILSON, B.: "Systems concepts, methodologies and applications". Wiley, New York, 1984
- WILSON, B.: "Systems: concepts, methodologies and applications"- Wiley, Chichester, 1984
- WILSON, B.G. (ed.): "Constructivist learning environments" - Educ. Technol. Publ., Englewood Cliffs, NJ., 1996
- WILSON, Donna: "Forms of hierarchy: a selected bibliography". SGSR Yearbook, 14, 1969
- WILSON, D.S.: "The Natural Selection of Populations and Communities" - Benjamin-Cummings, Menlo Park, CA, 1980
- WILSON, D.S. & SOBER, E.: "Reintroducing Group Selection to the Human Behavioral Sciences" - Behavioral and Brain Sciences, Vol.17, 4, p.585-608, 1994
- WILSON, E.O.: "The insect societies". Harvard Univ. Press, Cambridge, 1971
- WILSON, Edward O.: "Sociobiology: The New Synthesis" - Harvard Univ. Press, Cambridge, MA, 1975
- WILSON, Edward, O.: "Success and Dominance in Ecosystems: The case of the social insects" - Ecology Institute Oldendorf/Luhe, Germany, 1990
- WILSON, Edward O.: "Consilience: the unity of knowledge" - Abacus, London, 1998
- WILSON, Edward O.: "Scientists, Scholars, Knaves and Fools" - Amer. Sc., V.86, Nr.1, 1998
- WILSON, Edward O.: "L'enjeu Ecologique N°1" - La Recherche, N° 333, Juillet-Août 2000.
- WILSON, Kenneth L.: "Heinz von Foerster's contributions to the development of cybernetics". ASC Cyb.Forum, 9 (3) 1979
- WILSON, K.G.: "The renormalization group and critical phenomena" - Rev. Mod. Phys., 55 (3), 1983
- WILSON, Kenneth: "Les phénomènes de physique et les échelles de longueur". Pour la Science, Diffus. Belin, Paris, 1989
- WIMMER, M.: "Evolutionary roots of emotions" - Evol. & Cognit., 1(1), 1995
- WIMMER, Maria: "Moving towards a holistic approach to design socio-technical systems" - Proc. 8th IDIMT, Zador, Universitätverlag R. Trauner, Linz, 2000
- WIMSATT, W.C.: "Complexity and Organization" - in SCHAFFNER, K.N. & COHEN, R.S. (Eds): "Boston Studies in the Philosophy of Science", Vol.20, p. 67-86, Reidel, Dordrecht, 1974
- WIMSATT, W.C.: "Reductionist Research Strategies and their Biases in the Units of Selection Controversy" - in NICKLES, T. (ed.): "Scientific Discovery; Case Studies", Reidel, Dordrecht, 1980

- WINBURN, Robert W.: "Cybernetics, teleology and Science". *Cyb. & Systems*, 22 (5) 1991
- WINFREE, Arthur: "Some principles and paradoxes about the phase control of biological oscillations". *J. of Cyb.* nr.3 1977
- WINFREE, Arthur T.: "The geometry of biological time". Springer, New York, 1980
- WINIWARTER, P. & CEMPEL, Cz.: "Life symptoms: the behavior of open systems with limited energy dissipation capacity and evolution". *Syst. Research*, 9 (4) 1992
- WINIWARTER, Peter: "Ecological sustainability through power laws and laws of power"- *Proc. 42nd ISSS Meeting*, Atlanta, 1997
- WINKLER, Franz G.: "From relativity to duality: a holistic perspective"- *Procedd. 14th Meet. on Cybernetics and Systems*, Vienna, 1998
- WINOGRAD, T. & FLORES, F.: "Understanding computers and cognition: a new foundation for design" - Ablex Corp., Norwood, NJ., 1986, or Addison Wesley, Reading, MA.
- WINTREBERT, P.: "Le développement du vivant par lui-même". Masson, Paris, 1963
- WISDOM, John O.: "The hypothesis of cybernetics". *SGSR Yearbook*, 1, 1956 (First publ. in *Brit. J. Phil. of Science*, V.1, nr.2, 1951)
- WITOSZEK, N. & GULDBRANDSEN, E.(eds.): "Culture and environment- Interdisciplinary approaches". - Centre for development and the environment", Univ. of Oslo, 1993
- WITTEN, Ian H.: "Approximate, non deterministic modelling of behaviour sequences". *Intern. J. Gen. Systems*, 5 (1) 1979
- WITTEVEEN, W.J.: "Pursuing the spirits of the laws, in Arts, W.(ed.): Through a glass, darkly: blurred images of cultural tradition and modernity"- Brill, Leiden, 2000
- WITTGENSTEIN, L.: "Philosophical investigations" - Blackwell, Oxford, 1953
- WITZANY, Günther: "Natur der Sprache- Sprache der Natur: sprachpragmatische Philosophie der Biologie" - Königshausen und Neumann, Würzburg, 1993
- WITZANY, Günther: "Explaining and understanding Life" - *Semiotica*, 120(3/4), 1998
- WITZANY, Günther: "Life: the communicative structure. A new philosophy of biology"- Norderstedt: libri books on demand, 2000
- WITZER, Brigitte: "Kommunikation in Konzernen: Konstruktives Menschenbild als Basis neuer Kommunikationsstrukturen"- West Deutscher Verlag, Opladen, 1992
- WOCH, J.: "The necessity of constructivism as an epistemology of agents in the social sciences"- *Proc. 14th Meet. on Cybernetics and Systems*, Vienna, 1998
- WOKATSCH, Ditmar: "KAIZEN: common-sense principles to support quality management" - *Proc. 6th IDIMT Conference*, Zadov, Universitätverlag R. Trauner, Linz, 1998
- WOLDENBERG, Michael: "Spatial order in fluvial systems". *SGSR Yearbook*, 14, 1969
- WOLFRAM, S.: "Statistical mechanics of cellular automata"- *Rev. Mod. Phys.*, 55(3), 1983
- WOLFRAM, Stephen: "Universality and complexity in cellular automata". *Physica D*, 10 (1), 1984
- WOLFRAM, Stephen (ed): "Theory and applications of cellular automata". World Scientific, Singapore, 1986
- WOLFRAM, S.: "Cellular Automata and Complexity: Collected Papers" - Addison-Wesley, Reading, Mass., 1994
- WOLFRAM, S.: "The new science of complexity" - Addison Wesley, Reading, Mass., 2000
- WOLFRAM, S.: "A new kind of science"- Wolfram Media, Champaign IL, 2002
- WOLGAR, Steve (ed.): "Knowledge and reflexivity: new frontiers in the sociology of knowledge" - London, 1988 (no publisher mentioned)
- WOLKOWSKI, Zbigniew: "The concept of coherence considered as a systems isomorphism". *Syst. Research*, 9 (4) 1992
- WOLLIN, Andrew: "Punctuated Equilibrium: Reconciling Theory of Revolutionary and Incremental Change" - *SRBVS*, Vol.16, Nr.4, 1999
- WOLLMAN, A.: "The metabolism of cities" - *Sc.Amer.*, 213, 1965
- WOLTERECK, R.: "Ontologie des Lebendiges". F. Enke, 1940
- WOODCOCK, A & DAVIS, M.: "Catastrophe theory". Penguin, Harmondsworth, 1978
- WOODGER, J.H.: "The axiomatic Method in Biology". Cambridge Univ. Press, 1937
- WOODGER, J.H.: "Biological Principles". London, 1929 (as quoted by L. von Bertalanffy)
- WOODHOUSE, M.: "Holistic theories of time". *Revision* 3 (2), 1980
- WOODWARD, K. (ed.): "The myths of information: technology and postindustrial culture"- Routledge & Kegan Paul, London, 1980
- WORLD Commission on Environment and Development: "Our Common Future" - Oxford Univ. Press, New York, 1987
- WOSCHI, E.G.: "Fifty years of information theory: solved and unsolved problems"- *Proc. 16th Meeting on Cybernetics and systems*, Vienna, 2002
- WUKETITS, F.M.(ed.): "Concepts and approaches in evolutionary epistemology" - D.Reidel, Dordrecht, 1984
- WULF, Volker: "Evolving cooperation when introducing Groupware: a self-organization perspective"- *C&HK*, 6(2) 1999
- WUNSCH, G.: "Systemtheorie"- Geist & Portig, Leipzig, 1975
- XENOPOL, A.D.: "Teoría de la Historia" - Jorro, Madrid, 1911 (original in French, 1899, 1908, french publisher not mentioned in the Spanish translation)
- XU, Li D.: "Systems science: systems approach and information systems research (a collection of papers mainly by Chinese authors) - *SRBVS*, 17 (2), 2000
- YAM, Philip: "Branching out". *Amer. Scientist*, 82 (5) 1994
- YANAGITA, T. & KANEKO, K.: "Modeling and characterization of cloud dynamics"- *Phys. Rev. Lett.*, 78, 1997
- YATES, F.E.(ed): "Self-organizing systems: The emergence of order". Plenum Press, New York, 1987
- YI, Lin & MA, Y.: "Some properties of pseudo-harmonic systems"- *Internat.J. Syst.Sc.*, 20 (8) 1989
- YI, Lin: "Multi-level systems"- *Internat. J. Syst. Sc.*, 20(10) 1989
- YI, Lin & MA, Y.: "About the concept of continuity between general systems"- *IJGS*, 17(1) 1990
- YI, Lin: "Periodic linked hierarchies of systems" - *C&S*, 21(1) 1990
- YI, Lin & PORT, R.: "Several epistemological problems related to the concept of systems"- *Mathem. Comp. Modeling*, 14, 1990
- YI, Lin: "Stabilities and controllabilities of hierarchies of general systems"- *Cybernetica*, 34 (1), 1991
- YI, Lin & MA, Y.: "Hierarchies of general systems with S-continuous linkage mappings"- *Cybernetica*, 35(4) 1992
- YI, Lin: "Major diseases and modelling of epidemiologic transition: A.G.S. theoretic approach"- *C&S*, 26, 1995
- YI, Lin et al.: "Some unsolved problems in general systems theory"- (I., II) *C & S*, 28, 1997
- YI, Lin: "Discontinuity: a weakness of calculus and the beginning of a new era"- *Kybernetics*, 27(6/7) 1998
- YI, Lin: "The mystery of non-linearity and Lorenz's chaos"- Special issue of *Kybernetics*, 27 (6/7) 1998
- YI, Lin: "The past, present and future of systems science studies" (in chinese) - Beijing, 1998
- YI, Lin: "General Systems Theory: a mathematical approach"- Kluwer Academic & Plenum Publ., New York, 1999
- YI, Lin: "Some impacts of the second dimension"- *Proc. 15th Meet. on Cybernetics and Systems*, Vienna, 2000
- YOLLES, Maurice: "Management systems: a viable approach"- Pitman Publ., London, 1999
- YOLLES, Maurice: "Viable boundary critique"- *J. Operat. Res. Soc.* 52, 2001
- YOLLES, M. & GUO, Kaijun: "Paradigmatic metamorphosis and organizational development"- *SRBVS*, 20(2) 2003
- YONG PIL RHEE: "Functional linkage between democracy and market in capitalist systems"- *SRBVS*, 14(6) 1997
- YONG PIL RHEE: "Normative systems theory for sustaining democracy"- *Systems*, 2(1), Technical Univ., Wroclaw, Poland, 1997
- YONG PIL RHEE: "Complex systems models for the analysis of politics" - 42nd Conf. of ISSS, Georgia Technology Institute, Atlanta, 1998
- YONG PIL RHEE: "Democracy as self-organizing system"- *Systems*, 3(1), Technical Univ., Wroclaw, Poland, 1998
- YONG PIL RHEE: "The dynamics and complexity of political systems"- Ingansarang Press, Seoul, South Korea, 1999
- YONG PIL RHEE: "Toward a new theory of well-ordered polity"- *Systems*, 5 (1/2), Technical Univ., Wroclaw, Poland, 2000
- YOUNG, J.Z.: "A model of the brain". Oxford U.P., Oxford, 1974
- YOUNG, J.Z.: "Programs of the brain". Oxford U.P., Oxford, 1978
- YOUNG, J.Z.: "Philosophy and the brain"- Oxford Univ. Press, New York, 1987
- YOUNG, O.R.: "A survey of general systems theory". *SGSR Yearbook*, 9, 1964
- YOUNG, T.R. & SWARTZMAN, G.: "Public opinion, tradition and information half life". *Intern. J. Gen. Systems*, 1 (4) 1974
- YOUNGQUIST, Walter: "Geodesinies: the inevitable control of earth resources over nations and individuals" - National Book Co., Portland, OR, 1997

- YOVITS, M.C. & CAMERON, S.(eds): "Self-organizing systems". Pergamon, Oxford, 1960
- YOVITS, M.C. et al.(eds): "Self-organizing systems". Spartan Books, Washington, 1962
- ZABEL, Richard W. et al.: "Ecologically sustainable yield". *Amer.Sc.*, 91(2), March-Apr. 2003
- ZADEH, Lofti: "Fuzzy sets". *Inform. & Control*, 8 (p.338-53), 1965
- ZADEH, Lofti: "Fuzzy algorithms". *Information and Control*, 12 (p.94-102), 1968
- ZADEH, L. & POLAK, E. (Eds): "Systems theory". Mc Graw Hill, New York, 1969
- ZADEH, Lofti A.: "Similarity relations and fuzzy orderings". *Information Sciences*, 1971
- ZADEH, Lofti A.: "Preface to 'Introduction à la Théorie des Sous-Ensemble flous'. by A. KAUFMANN, Masson, Paris 1973a
- ZADEH, Lofti A.: "Outline of a New Approach to the Analysis of Complex Systems and Decision Processes". *IEEE Transac. on Systems, Man & Cybernetics*, Vol. SMC 3, Nr. 1, 1973b
- ZADEH, L.A. et al: "Fuzzy sets and their applications to cognitive and decision processes". Academic Press, New York, 1975
- ZADEH, Lofti A.: "Fuzzy sets as a basis of a theory of possibility". *Fuzzy Sets Systems*, 1, (p.3-28), 1978
- ZADEH, Lofti A.: "Fuzzy logic and approximate reasoning". *Synthese*, 30 (3/4) 1975
- ZADEH, L.: "A note on prototype theory and fuzzy sets" - *Cognition*, 12, 1982
- ZAHAAR, Elie: "Essai d'Epistémologie réaliste"- Vrin, Paris, 2001
- ZAIKIN, A.A. & SCHIMANSKY-GEIER, L.: "Ordering role of additive noise in extended media" - *CASYS J.*, 3, Inst. of Math., Univ. of Liège, Belgium, 1999
- ZAMAGNI, Stefano: "La Globalización como Condición Específica de la Economía Post-Industrial" - Departamento de Ciencias Económicas, Univ. de Bologna, Nov 1995 (Spanish translation by Juan Cavo, Universidad del Salvador, Buenos Aires) - 1997
- ZEEMAN, E.C.: "Catastrophe Theory". Addison Wesley, Reading, Mass., 1977
- ZEEUW, Gerard de: "Problems of psychological and artificial intelligence" in ELITHORM, A. & JONES, D. (eds): *Artificial and human thinking*, Elsevier, Amsterdam, 1973
- ZEEUW, Gerard de (ed.): "Knowledge (dis)appearance" - *Systemica*, 6, (1/6), 1986
- ZEEUW, Gerard de: "The power of language"- *Systemica*, 7 (1/6), 1989
- ZEEUW, Gerard de: "Chaotic interaction: preparing for survival" in GEYER, F. (ed.): *The cybernetics of complex systems*. Intersystems, Los Angeles, 1991
- ZEEUW, G.de & GLANVILLE, R. (eds.): "Collective support systems and their users" - Thesis Publishers, Amsterdam, 1991
- ZEEUW, Gerard de: "Interaction and global formulation" - *Systemica*, 8 (1/6), 1991
- ZEEUW, Gerard de: "Autopoiesis and social systems; a counterresponse" - *IJGS*, 21(2), 1992
- ZEEUW, Gerard de: "Competence and the observational language" in TRAPPL, R. (ed.): *Cybernetics & Systems Research'92*, 2, World Scientific, Singapore, 1992
- ZEEUW, Gerard de: "Is chaos te zien?" -in van Dijkum, C. & de Tombe, D.(eds.): "Gamma chaos: Onzekerheid en Orde in de Menswetenschappen" (in Dutch)- Aramith, Blumendaal, Netherlands, 1992
- ZEEUW, Gerard de: "Systems languages and local cultures"- in RODRIGUEZ ULLOA, R. (ed.): "Desarrollo de una Sociedad", IAS, Lima, 1992
- ZEEUW, Gerard de: "Improvement and research: a Paskian evolution"- *Syst. Res.*, 10, 1993
- ZEEUW, Gerard de: "The actor as a perfect citizen" - in STOWELL, F.A. et al.(eds.): *Addressing global issues*. Plenum Press, New York, 1993
- ZEEUW, G.de & KOPPELAAR, H.: "Objects, systems and invariants" - *Systemica*, 10, 1995
- ZEEUW, Gerard de: "Values, science and the quest for demarcation". *Syst. Research*, 12 (10) 1995
- ZEEUW, Gerard de: "Action and social order research"-in BOOG, B. et al. (eds.): *Theory and Practice of Action Research*, Tilburg Univ. Press, Tilburg, Netherlands, 1996
- ZEEUW, Gerard de: "Second order organisational research". Working paper nr.7, University of Humber-side, Hull, 1996
- ZEEUW, Gerard de: "Second order organizational research" - in ACHTERBERG, J. et al. (eds): "Organizational Cybernetics" - Nijmegen Business School, Nijmegen, Netherlands, 1997
- ZEEUW, G.de & VAHL, M.: "What does a self-referential research methodology look like?" - *Systemica*, 11, 1997
- ZEEUW, Gerard de: "Improving on differences among viewpoints" -in BOOG B. et al (eds): "The complexity of relationships in action research." - Tilburg Univ. Press, Tilburg, 1998
- ZEEUW, G.de et al.: "Problems of participation and connection" - *Systemica*, 13, 2001
- ZEEUW, Gerard de: "A Festschrift: papers by M.C. Jackson, R. Glanville, M. Vahl"- *SRBVS*, 19(2) 2002
- ZEIGLER, Bernard P.: "A conceptual basis for modeling and simulation". *Intern. J. Gen. Systems*, 1 (4) 1974
- ZEIGLER, Bernard P.: "Simulation based structural complexity of models". *Intern. J. Gen. Systems*, 2 (4) 1975
- ZEIGLER, Bernard P.: "Theory of modelling and simulation". Wiley, New York, 1976
- ZEIGLER, Bernard P.: "Structuring the organization of partial models". *Intern. J. Gen. Systems*, 4 (2) 1978
- ZEIGLER, Bernard P.: "Multifaceted modelling and discrete event simulation". Academic Press, London, 1984
- ZEIGLER, B.: "Knowledge representation from Newton to Minsky and beyond" - 8th European Meeting on Cybernetics & Systems Research, Vienna, 1986
- ZEIGLER, Bernard P.: "Systems knowledge: a definition and its implications", In Elzas, M.S. et al (eds): "Modelling and simulation in the artificial intelligence era". North Holland, Amsterdam, 1986
- ZEIGLER, Bernard P.: "Multifaceted modelling methodology: Grappling with the irreducible complexity of systems". *Behav. Science*, 29, 1994
- ZEIGLER, B. et al.: "Theory of modeling and simulation" - (2 ed.) - Academic Press, London, 2000
- ZEITLER, U. (ed.): "Transport ethics: selected essays"- Aalborg Univ. Press, Denmark, 2002
- ZEITLINGER, Anton: "A foundational Principle for quantum mechanics"- *Foundations of Physics*, 29, apr.1999
- ZELENY, M. & PIERRE, N.A.: "Simulation of self-renewing systems", in Jantsch, E. & Waddington, C.(eds): "Evolution and consciousness". Addison Wesley, Reading, Mass., 1976
- ZELENY, Milan: "Self-organization of living systems: a formal model of autopoiesis". *Intern. J. Gen. Systems*, 4 (1) 1977
- ZELENY, Milan: "Autopoiesis, Dissipative structures and spontaneous social order". Westview Press, Boulder, CO, 1980
- ZELENY, Milan (ed): "Autopoiesis: a theory of living organization". North Holland, New York, 1981
- ZELENY, Milan: "On the (ir)relevancy of fuzzy set theory". *Human systems management*, 4, 1984
- ZELENY, M.: "Autopoiesis and self-sustainability in economic systems" - *Hum. Syst. Manag.*, 11, 1997
- ZELEZNIKAR, Anton P.: "Information determinations 1". *Cybernetica*, 31 (3) 1988
- ZELEZNIKAR, Anton P.: "Formal informational principles". *Cybernetica*, 36 (1) 1993
- ZELLER, C.: "A geometric model with some properties of biological systems". *SGSR Yearbook*, 12, 1967
- ZERBST, Ekkehard: "The impact of von Bertalanffy on Physiology", in Laszlo, E.(ed): "The relevance of General Systems Theory". Braziller, New York, 1972
- ZERUBAVEL, B.: "The fine line: making distinctions in everyday life" - Univ.Chicago Press, Chicago, 1993
- ZERZAN, John & CARNES, Alice (Eds): "Questioning Technology: Tool, Toy or Tyrant?". New Society Publ., Santa Cruz, California, 1991
- ZHONGTUO, Wang: "Meta-decision making: concepts and paradigm"- *SPAR*, 13(1), 2000
- ZHU, Zhichang: "Conscious mind, forgetting mind: two approaches in multimethodology"- *SPAR*, 11(6) 1998
- ZHU, Zhichang: "Trinitarian relation inquiry system in systems management approaches?" - *Proc. 42nd Annual Conference of the ISSS*, Georgia Technology Institute, Atlanta, 1998a
- ZHU, Zhichang: "Confucianism in action: Recent developments in Oriental systems methodologies" - *SRBVS*, Vol 15,(2), 1998b
- ZHU, Zhichang: "An International Project: Systems East and West" - *SRBVS*, Vol.16, (3), May-June 1999a
- ZHU, Zhichang: "Integrating ontology, epistemology and methodology in information systems design - The WSR case" - 43rd Annual Conference of the ISSS, Asilomar,CA., 1999b
- ZHU, Zhichang: "The practice of multimodal approaches, the challenge of cross-cultural communication and the search for responses" - *Human Relations*, Vol.52, Nr.5, 1999c
- ZHU, Zhichang: "Systems approaches: Where the East meets the West" - *World Futures*, 53, 1999d
- ZHU, Zhichang: "Integrated Decision-Making: A Confucian Model" - Lincoln School of Management, Lincoln, England, 1999e
- ZHU, Zhichang: "Dealing with a differentiated whole: the philosophy of the WSR approach"- *SPAR*, 13(1) 2000
- ZIEMKE, Axel: "System und Subjekt: Biosystemforschung und radikaler Konstruktivismus". Vieweg, Wiesbaden, 1992

- ZIMMER, Carl: "Parasite Rex" - Free Press, Glencoe, New York, 2000
- ZIMMER, Karl: "Life after Chaos"- Science, Vol.284, Nr.5411, April 2, 1999, p. 83-86
- ZIMMERMAN, H.J.: "Fuzzy sets, decision making and expert systems" - Kluwer Academic, Boston, 1993
- ZIMMERMANN, Hans J.: "Description and optimization of Fuzzy systems". Intern. J. Gen. Systems, 2 (4) 1976
- ZIPF, G.K.: "Human behavior and the principle of least effort" - Addison Wesley, Cambridge, MA., 1949
- ZOHAR, D. : "The quantum self" - Quill/W. Morrow, New York, 1990
- ZOLO, D.: "Autopoiesis: critique of a post modern paradigm"- Telos, 86, 1990
- ZUBER, Marcelina: "System perspective in communication: some examples"- Systems, 4(1-2) Polytechnical Univ. Wroclaw, Poland, 1999
- ZUREK, W.H.: "Complexity, entropy, and the physics of information" - Addison Wesley, Reading, Mass., 1990
- ZUSE, Karl: "Ansätze einer theorie des Netzautomaten" - Nova Acta Leopold, Neue Folge, 43(220), 1975
- ZWICKY, F.: "The morphological method of analysis and construction"- Interscience Publ., New York, 1968
- ZWICKY, Fritz: "Entdecken, erfinden, forschen in Morphologischen Weltbild". Knauer, München, 1971
- ZWIRN, Hervé: "Des agents pour prévoir l'imprévu"- La Recherche, 353, mai 2002
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Charles François is a Belgian citizen, born 1922 and retired from the Belgian Foreign Service since 1987. He was educated in Belgium and lived in Central Africa from 1945 to 1960, first as an administrative officer and later on as owner of his own business. His first contact with Cybernetics was in 1952 through Wiener's foundational 1948 work on Cybernetics.

In 1958 he became a member of the former Society for General Systems Research (Now ISSS). Participant from 1970 on in numerous Meetings of various Systems and Cybernetics Societies, he is also member of the board of some of them, and integrates the editorial board of various journals on Systems and Cybernetics. Author of numerous papers on systemic topics, he also published in French a book on: «Cybernétique et Prospective» (International Association of Cybernetics, Namur, 1976) and an «Introducción a la Prospectiva» in Spanish (Pleamar, Buenos Aires, 1978). In 1985 he published in Spanish his study on «El uso de Modelos Sistémicos-Cibernéticos como metodología científica (Systemic-Cybernetic Models used as scientific methodology) and in 1986 «Enfoques Sistémicos en el Estudio de las Sociedades» (Systemic Approaches to the Study of Societies).

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